DOCUMENT RESUME

ED 197 644 HE 013 408

AUTHOR Killian, C. Rodney, Ed.
TITLE Reasoning, Piaget and Higher Education. Conference Proceedings.
PUB DATE 80
NOTE 107p.: Papers presented at the National Conference of Reasoning, Piaget, and Higher Education (1st, Denver, CO, April 10-11, 1980).

EDRS PRICE MF01/PC05 Plus Postage.
DESCRIPTORS *Abstract Reasoning; *Cognitive Development; Cognitive Style; *College Instruction; Concept Formation; *Developmental Stages; *Developmental Studies Programs; Higher Education; Intellectual Development; *Learning Theories; Logical Thinking; Problem Solving; Remedial Programs; Science Education; Writing (Composition)
IDENTIFIERS *Piagetian Theory

ABSTRACT

Papers presented at the 1980 National Conference on Reasoning, Piaget, and Higher Education are presented which address the implications of Piaget's research on the teaching of reasoning skills in higher education. Contents include the following: "Piaget: An Agenda, Not an Answer for the 80s," by Catherine M. Warrick; "Project SOAR," by Jacqueline Hunter et al; "Identifying and Developing Advanced Cognitive Skills Through the Composing Process," by Paul D. Farkas; "Piaget Is Not Enough," by Maureen P. Lancaster; "Piaget and Curriculum," by Susan Hofmann; "DORIS: Development of Reasoning in Science, A Course in Abstract Thinking," by Francis P. Collea and Susan Nummedal; "Background Information and Summary of Presentation--DOORS," by Thomas Campbell et al.; "Adaptation of Cognitive Instructional Approaches to Working with Learning Disabled Students," by Eva Dyer; "ADAPT: Past, Present and Future," by J. A. McShane; "Assumption: Language is the Tool," by Patricia Killian; "Learning Cycles in Chemistry," by Sharon Hahs; "The Search for Mental Structure: Reality or Rhetoric," by Darrell Phillips; "Piagetian Interviews of College Students," by Elizabeth Carpenter and Robert Fuller; "The Learning Cycle in Physics," by Jerry H. Wilson and Gerald O'Halloran; "The Learning Cycle in Earth Science," by Elizabeth Friot; "Workshop on the Role English Teachers Can Assume with Piaget," by Avalon Williams; "Overview of Piagetian Stages with Emphasis on Formal p Operations," by Myra Bookman; and "The Learning Cycle and Reading," by Elaine Cohen. (SW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

HE

ED197644

REASONING, PIAGET AND HIGHER EDUCATION

Conference Proceedings

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

C. Rodney Killian

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Editor: C. Rodney Killian, Ph.D.

1980

HE 013 408

TABLE OF CONTENTS

	Page
Introduction	
Piaget: An Agenda, Not An Answer For the 80s Catherine M. Warrick.	1
Project SOAR Jacqueline Hunter, Lester Jones, Harold A. Vincent. . . .	16
Identifying and Developing Advanced Cognitive Skills Through the Composing Process Paul D. Farkas.	17
Piaget is Not Enough Maureen P. Lancaster.	29
Piaget and Curriculum Susan Hofmann	35
DORIS: Development of Reasoning in Science, A Course in Abstract Thinking Francis P. Collea, Susan Nummedal	37
Background Information and Summary of Presentation - DOORS Thomas Campbell, Karl Taylor, Richard Thompson.	38
Adaptation of Cognitive Instructional Approaches to Working with Learning Disabled Students Eva Dyer.	41
ADAPT: Past, Present and Future J. A. McShane	60
Assumption: Language is the Tool Patricia Killian.	61
Learning Cycles in Chemistry Sharon Hahs	69
The Search for Mental Structure: Reality or Rhetoric Darrell Phillips.	73
Piagetian Interviews of College Students Elizabeth Carpenter and Robert Fuller	83
The Learning Cycle in Physics Jerry H. Wilson and Gerald O'Halloran	84
The Learning Cycle in Earth Science Elizabeth Friot	85
Workshop on the Role English Teachers can Assume with Piaget Avalon Williams	86
Overview of Piagetian Stages with Emphasis on Formal Operations Myra Bookman	87
The Learning Cycle and Reading Elaine Cohen	96
References	97
Conference Presenters	100

JAN 19 1981

Introduction

The National Conference on Reasoning, Piaget, and Higher Education convened in Denver for the first time on April 10-11, 1980. This first annual conference was sponsored by Metropolitan State College and endorsed by the American Association of State Colleges and Universities. One hundred forty-five educators and friends of education from 27 states and some 60 institutions of higher education participated in this premier conference.

The conference addressed the implications of Piaget's research on the teaching of reasoning skills in higher education. Participants were provided the opportunity to exchange information, learn, and share ideas on theory, programs, and practical applications. The papers dealing with the teaching of reasoning skills in higher education are presented in these proceedings.

For the reader not already familiar with Piaget's stages of cognitive development and the learning cycle model, I will take a few paragraphs to summarize each.

Piaget characterized cognitive development as continuously progressing through four stages: Sensory Motor (age: 0-2 years), Preoperational (age: 2-7 years), Concrete Operational (age: 7-11 years), and Formal Operational (age: 11-15 years). The order of succession is the same for all children, but the chronological ages attached to each stage by Piaget may vary considerably from one social environment to another.

Research has shown that cognitive development is gradual and that many students appear to be in between two stages. This is especially true of college

freshmen. Many freshmen demonstrate Formal Operational thinking on some tasks and Concrete Operational on others; thus in a transition stage.

Piaget also presented the concept of equilibration; seen to him as a fundamental factor. Equilibration is an active process of self-regulation that a learner engages in while interacting with a new situation or stimulus. Thus, as the learner processes information, modifying his/her mental structures, changes occur and the learner develops cognitively.

As a classroom approach designed to facilitate the process of self regulation, Karplus et. al. (1977) developed the learning cycle model: exploration, concept introduction, and concept application. During exploration, students investigate new materials and ideas with minimal guidance; thus drawing upon past knowledge and experiences. In the second phase, concept introduction, the teacher (or any medium such as a film, video-tape, etc.) introduces a new concept that leads the learners to applying new reasoning patterns to their experiences. This phase should relate directly to the explatory activities of the first phase. Lastly, concept application, provides the learner with additional examples and activities to which to apply the new concept or reasoning pattern.

Programs utilizing the learning cycle model as well as specific discipline examples were presented at the conference. Papers in the proceedings are presented in the same order as they appeared on the program. No attempt for categorization was made.

Some of the papers included in these proceedings are in abstract form. They represent those presentations that were workshops, panel discussions, or

video-tape discussion. Abstracts are reprinted with permission from the Franklin Institute Press. Session abstracts were printed in the June, 1980 issue of Problem Solving. A complete listing of references cited in each paper will be found at the end of the proceedings.

I am grateful to the authors contributing to these proceedings and to the many people who helped make the conference an outstanding success.

C. Rodney Killian, Ph.D.
Colorado Department of Education
September, 1980

PIAGET: AN AGENDA, NOT AN ANSWER FOR THE 80'S

Catherine M. Warrick

I. Introduction

There is something about beginning a new decade that causes one to stop, look back, and try to project ahead more than is usually the case. Perhaps it is because we have a decimal based monetary system as well as a decimalized numbering system, but we do think about time and its passing most conveniently in decades and centuries, and the start of a new decade is bound to cause speakers of all sorts to begin speculation about what lies ahead and to attempt to characterize what has just passed. A number of decennial summaries have already been offered about the 1970's; it was the age of egocentricism, the decade of individuality triumphing over community; some call it narcissistic while others say it was "liberating"; the "me generation" looks like a label that might stick. These general appellations are probably not far amiss as descriptors for some of the things which tried to flower in higher education in the decade just past -- the emphasis on individualized degree programs and majors, trying to fit education to the individual style of the learner, the relaxing of common degree requirements for graduation particularly in what has been called the distribution requirement, and a growing concern with taking the opportunity for higher education to the learner whether she/he is in prison, restricted by geography, work, home responsibilities, or isolated by language, culture, and inadequate early schooling.

I am willing to risk a guess that in the 1980's we will feel that the loss of commonality in undergraduate education has been a serious mistake, and we will attempt to recapture a common meaning for the baccalaureate degree, an earlier meaning that was lost long before the infamous 70's. I hope we do not return to a preoccupation with credit hours distributed across specific academic subjects;

that would be no gain at all. But if we return to the older values of a liberal education, to be able to communicate effectively with grace and force, to be able to think (induce, deduce, compare and contrast, analyze, synthesize, apply, evaluate), to be creative in at least one aspect of life, to have self-knowledge (one's own values, cultural limitations, world view, predispositions, assumptions about reality, etc.), to have self-control and judgment (know when to be disciplined, when to be free, when to listen and observe, when to be quiet and when to speak), then we will be back onto the road that will lead to a revaluing of formal education and what it can do for people that is much needed in all areas of human experience today.

This prediction, assertion, or better perhaps, this hope, brings me neatly to what I am supposed to be talking about today. Here we are in the spring of a new decade meeting to talk about a very important movement that is gaining momentum and credence in higher education today -- the development of reasoning in college students through Piaget-based instruction. Does it have the potential to help us address some of our most persistent concerns about the meaning of a college degree, about success and failure in the teaching mission of higher education?

You will have the chance to explore these questions with an exciting array of people in the next two days. The program features experimenters from California, Illinois, Colorado, Nebraska, Louisiana, Iowa, and Minnesota, and I have personal knowledge of important, similar work being pursued in New Jersey, Massachusetts, North Carolina, Texas, and who knows where else. College-level, Piaget-based teaching is already underway in most major disciplines -- biology, chemistry, child development, English, economics, the earth sciences, the health

sciences, history, mathematics, business education, management science, reading, psychology, sociology, physics, and philosophy. I am certain there are other efforts I know nothing about. Metropolitan State College has created what should be a rich opportunity for exchange during the next two days for each of us, regardless of our varying degrees of familiarity with Piaget-based instruction or of the disciplines to which we claim allegiance.

II. What Does Piaget Offer Us?

Dr. Killian asked that in opening this conference I keep in mind the wide range of people who were likely to attend, so I will take the time to define some terms that are likely to surface frequently in the course of the next two days and which are important in grappling with the questions I want to raise this morning. Let me start with what I mean when I refer to Piaget-based instruction or Piagetian instruction.

The Swiss psychologist, Jean Piaget, has developed a hypothesis that learning to reason is a growth process which passes through discernible stages that are the same for all people, that is, they are invariant. He describes the hierarchy as sensorimotor operations leading to a preoperational stage, which leads to a concrete operational stage, which culminates in a formal operational stage. His work originally suggested that the formal operational stage of reasoning appeared in students at about the age of 16 (Inhelder, 1958). As a result of his designation of 16 as the age when the process culminates, his work received little attention from people concerned with educating older age groups, since this developmental process would have been assumed to have already occurred. However, as some early experimenters read his descriptions of concrete thinking versus formal thinking, suspicion began to grow that may college students seemed to resemble the concrete description more than the formal description. In short, an illumination or when faced with formal-level material, but will apply them with little understanding.

a great AHA! occurred. There was a special face validity to Piaget's conceptualizations; at least, professors who cared a great deal about wanting students to really understand their disciplines saw isolated in Piaget's descriptions some of the critical differences which they had long felt and observed between those students who were "good" or did well in their courses and those who did not. Thus, Piaget had devised a conceptual framework for explaining what had previously been frustrating and discouraging. Since he had also given some descriptions about how cognitive development seemed to occur, the next logical step was to try to figure out how to cause concrete thinkers to become formal thinkers, that is, how to cause all students to possess and use those reasoning skills which we have long associated with the outcomes of college-level education.

Perhaps at this point it would be well to describe how a concrete thinker differs from a formal thinker so that those of you who are new to this movement can appreciate what we are all huffing and puffing about, so that you will "know one when you see one." A concrete thinker needs reference to familiar objects, actions, and observable properties in order to "think" or reason. When such material is available to him, this person can use classification, conservation, serial ordering, and one-to-one correspondence in dealing with the material, but if a lengthy process or procedure is involved, he will require step-by-step instructions. A good example of this difficulty is the differences many of you have observed between the elaborateness of instructions required by strong and weak students when it comes to doing a term paper. There almost seems to be a law that the poorer papers are from the students who asked for the most explanations and clarifications. Further, the concrete thinker is not usually aware of his own reasoning, the inconsistencies he exhibits, or the contradictions with other known facts which he seems unable to recognize. Such a person will often resort to memorizing prominent words, phrases, formulas, and procedures

when faced with formal-level material, but will apply them with little understanding.

On the other hand, a formal thinker can "think" or reason using very abstract symbols, concepts, and properties; she will apply combinatorial, classification, conversation, serial ordering, and proportional reasoning to quite intangible material. She can plan procedures knowing only the goals to be achieved and the resources available, and she is aware and critical of her own reasoning, checking the validity of her conclusions against other known information.

I'm sure you will agree that it is the latter student, not the former, who we wish to see as a graduate of our particular colleges. In fact, on the days we are most honest, it is the latter student we would like to limit higher education to in the first place. We want students already to be formal when we admit them to our college classes. Wish that it were so! It would make teaching a lot easier.

But, it isn't so! In fact, you are likely to learn in the course of these two days that probably 50% of all freshmen are concrete thinkers (Fuller, 1976), with the proportion being much higher in some institutions where open admissions is the policy. Further, concrete thinkers have been known to appear in upper division liberal arts and professional courses as well. An additional depressing fact is that some adults never exhibit reasoning patterns that could be called formal.

Well then, what does Piaget say about how reasoning develops? Roughly, he describes a process called self-regulation by which a person finds himself in a situation where his old problem-solving (thinking) skills aren't adequate; this

causes frustration (Other words which might be used to describe this experience are stress, cognitive dissonance, disequilibrium); the person seeks to regain equilibrium or reduce stress by finding other ways to think or conceptualize or problem-solve that will work; through successful coping, a new operation is substituted for or added to the old operation and equilibrium is restored. Piaget claims this is the natural and most effective way to learn, and if he is right, the notion of what constitutes good teaching probably needs major revision.

One important and successful effort to design a teaching system based on Piaget's concept of self-regulation is the Learning cycle approach of Robert Karplus (1977). It was developed to facilitate the teaching of physics but has been used since with a number of other natural sciences and has been adapted for the social sciences and humanities as well. The Learning Cycle begins with a phase called Exploration in which disequilibrium occurs; indeed, it is the instructor's task to make certain it occurs. Following Exploration is a phase called Invention, the time when more satisfactory means of coping, new concepts, new relationships must be discovered or introduced. Finally comes Application, the stage when new devices must be tried again or tested out for adequacy. You will hear much more about the Karplus model before this conference is over.

But let me summarize this introduction to Piagetian teaching at the college level. We are concerned about helping students become skillful in reasoning. Piaget seems to have described the state where many of our students are in reasoning and also the state where we want them to be; he has also suggested self-regulation as the natural process for making the change. We are much excited about the possibilities inherent in thinking about our students in this way; indeed, positive results have already been achieved in some of the programs featured at this conference: STAR, ADAPT, SOAR, DOORS. But really, Piaget has not provided us with an answer for our problem; he has just suggested a good place to start.

What I really want to discuss this morning is some possible items for a Piagetian, higher education agenda in the 80's.

III. The Agenda

Naturally, the agenda is based on what I believe we need to learn about developing reasoning ability in college students. I don't wish to join the debate on whether there is such a phenomenon as cognitive development. I know the debate goes on, but I assume you are at least open to the possibility that cognition follows some developmental path or you would not be here at all. My agenda may well differ from that of other people who are thinking about this subject, including some of you, but I believe you will find my agenda provocative if incomplete.

1. One of the large issues raised by Piaget's concept of how cognitive growth actually occurs is the question of whether a sufficently stimulating environment will cause a person to invent new, more effective operations to handle the disequilibrium without further intervention by a teacher. This is a matter which has enormous pedagogical implications. One view holds that the teacher's role is simply to create the right problems, situations, materials which require the student to grapple at a level of cognition just above the one she/he is already at (Duckworth, 1979). A second view is that an instructor's intervention at the proper moment in the grappling process will cause the process to occur more rapidly and surely (Kuhn, 1979). After all, learning everything by unmediated experience is both time-consuming and very frustrating for the individual. In fact, there is a risk that the individual will give up, quit trying, if resolution escapes him too long. All of us have known students and other people who have quit trying.

The point in raising this issue is that we really don't know for certain

which view is closer to the truth. Much work is needed on questions like: Is there such a thing as readiness to make a leap in cognitive development without which all instruction is in vain? Do you run the risk of "turning a student off" if you keep asking for the development of a cognitive operation for which he is unready? Are there special skills of questioning, guiding, and encouraging which instructors will need if they are to teach well using a discovery approach? What are the increments that constitute "optimal mismatch", that is, setting a task or problem just above the student's present ability so that it challenges but does not defeat him? Can you hope to do "optimal mismatching" for a whole class of students of diverse abilities? Isn't that asking for a kind of individualization of instruction which we are very unlikely to be able to finance and which we lack the diagnostic skills to provide? Wouldn't it be better to create a learning environment with the full range of challenges in it and then evaluate on which level of challenges each student masters?

Exploration of these issues is occuring at the University of Massachusetts and the University of Nebraska and probably other places, but there is much more room for others to become involved. We need to know just how much teaching intervention, if any, facilitates the move to higher cognitive functioning.

2. A second major agenda area is the question of what constitutes formal operations in the various disciplines. Piaget originally derived his characteristics of formal thought from physics, and I think that it is not surprising that Karplus is a physicist and that more progress seems to have been made in applying Piaget to physics teaching than to any other field. There has also been pretty good translating from formal operations in physics to formal operations in other natural sciences like mathematics and chemistry, but what are the formal operations of history, literature, sociology, or art? This is one area of

development that should challenge most of us. We cannot hope to design instruction that will advance formal thinking in the humanities or social sciences until we can be quite specific about what that means.

Take history for example, R. N. Hallam, an Englishman who is concerned about historical thinking and how to develop it in students, has tried to describe the characteristics of pre-operational thinking, concrete thinking, and formal thinking as they are exhibited in the study of history. Some of the physics operations just don't apply, while some do. Ratio or conservation operations have little place in the mastery of history, but handling multiple variables is critical. To consider possible cause and effect relationships in history, it is essential to be able to manipulate many potential variables with attention to ordering in time and place, but what are the other operations that characterize formal thought in history?

Hallam (1970), found that pre-operational thinkers tended to isolate on single features of the data, leaving important data out altogether. He found concrete thinkers to be accurate in handling particular passages of historical matter but unable to incorporate from more than one source. However, the formal thinkers were able to visualize multiple explanations and linkages and could precede to test out various hypotheses against various data. He also found that students seemed to be able to function formally in the natural sciences earlier than they were able to in history, suggesting that some disciplines may be inherently more abstract than others, and therefore more difficult to acquire formal operations in. History from all operations seemed to follow about two years later than formal operations in the sciences.

The specific reasoning operations required for various subjects is a rich and rewarding field for inquiry; fascinating questions are raised. Can formal thought

be attained in some subjects earlier than in others? What does this suggest about the organization of the curriculum? Do we really understand at a conscious level what is required by our disciplines in the way of thought processes? Is the freshman year the best time to teach the term paper? Is logic perhaps "easier" in the formal operations it requires than a survey of western philosophy? This area of inquiry has particular personal appeal for me because my disciplinary area is the humanities, English and history to be specific.

3. A third important area of concern, if one accepts that cognitive growth is sequential and invariant, is that it is impossible to ignore questions about how cognitive growth is linked to psycho-social and moral growth. There is a large array of hypotheses about other growth processes to stimulate your thinking. You may be attracted to Erik Erikson's eight stages of growth; you may find Maslow's hierarchy appealing; perhaps Lawrence Kohlberg's thoughts on moral development ring particularly true for you. I have been intrigued by William Perry's efforts to link intellectual and ethical development in college students. What I think you will discover if you make a systematic study of the various stages of any of these growth schemes as compared to concrete vs. formal thinking is that there are striking parallels. Perry's stage of commitment would be literally impossible for a concrete thinker. The issues one confronts in Erikson's stage of identity vs. role confusion may not be fully resolvable for a concrete thinker. Maslow's growth needs above the level of "belongingness" are all based on ideas, concepts, abstract relationships which a concrete thinker would be very hard-pressed to internalize, and certainly Kohlberg's social contract and moral principle orientations would appear to be unlikely orientations for a concrete thinker.

This realization has been very sobering for me. It seems likely that most of the personal and social ideals we have held for ourselves, others, and

society in general are linked to a level of reasoning ability that we have only begun to study systematically in the last few years, and in fact, we know that it is a level not attained by at least some of the present adults in our society.

Just how these developmental stages are linked to cognitive development is not clear. Do certain psych-social stages preclude serious cognitive development at particular times in one's life? Do certain psycho-social age groups have a greater need to understand, to grow cognitively than others? Do we have the wrong age groups in college? Those of us who teach in institutions with large numbers of adult students have found ourselves more attracted to working with the older students than the young ones. On the whole they seem to learn more quickly and be more interested in learning. Is it because they are cognitively ready to become formal thinkers where 18-year-olds are not? We have not begun to understand the relationships between these various developmental frameworks, but we should be very conscious that the relationships are probably there.

4. There are also many other facets of cognitive functioning which need to be woven into a strong fabric of understanding about cognitive development in addition to Piaget's insights. Take for example the work which has been done on field-dependent and field-independent cognitive orientations. In the San Diego area as well as at Metropolitan State College in Denver, some work has been pursued on whether the Karplus learning cycle favors the field-dependent or the field-independent person. Early results suggest that the learning cycle approach favored every type of learner, but most of all those learners who were at the extreme ends of the field-dependent, field-independent continuum. I am fascinated by that outcome, because I initially feared that field-dependent learners would be handicapped by discovery learning. Actually, most traditional teaching approaches have tended to favor the great middle group of learners in any given class. We

unconsciously gear ourselves, I think, to teach to the middle of a class, partly as a means of survival. We need much more experimentation on which kinds of learners prosper most through which learning strategies so that we know how to initially engage them all.

However, I am growing suspicious that certain cognitive styles are really manifestations of concrete thinking, and we cannot let students hang on to those styles if in doing so they never attain formal operations abilities. I have also reached the tentative conclusion that the dichotomy which has been set up between learning experientially and traditional school learning (as described by James Coleman 1974) is utterly false. As evidence, I offer the striking similarity between natural learning as described by Piaget and the Kolb-Fry model of learning which permits the identification of four basic learning orientations in a circular pattern rather than a linear one (Kolb, 1975). The important contribution of the Kolb-Fry model is that while a person may have a preferred learning orientation, the model requires that a person complete the learning circle, using all four learning orientations, before it can be asserted that full learning has occurred. The four stages in this model are labelled concrete experience, reflective observation, abstract conceptualization, and active experimentation. Sounds very much like exploration, invention, and application, doesn't it? What's more it seems as though an individual can begin in the Kolb-Fry circle at more than one place, just so all the stages are passed through before the experience is ended. A start at one point follows a path not unlike deductive reasoning, while a start at a different point resembles inductive reasoning.

The point of this rambling about different models of cognition is simply to say that I believe much will be learned by efforts to integrate some of these conceptual frameworks in any instructional design, and the work does need to be done.

5. Finally, there is the question of whether culture is a confounding variable in the attainment or appearance of the last two stages of cognitive development -- the concrete and the formal. Carol Gilligan believes that she has found differences between men and women in the structure of the last two stages of moral development as Kohlberg has described them, and of course, Kohlberg's work grows out of Piaget (Carol Gilligan, 1978). There is little doubt that women become acculturated in some ways distintively different from men, but should that effect cognitive development?

More work has been done with cross-cultural studies of the universality of Piaget's cognitive stages, and it is clear that cultural factors can delay the appearance of the latter two stages. It is also true that for some people in every culture, the final-- formal-- stage of development never seems to appear. However, much criticism has been leveled at measuring devices in these studies, leaving the question unanswered as to whether the unfamiliarity of the material some subjects are asked to manipulate causes the apparent differences rather than actual cognitive difference. One frightening side-product of the cross-cultural studies is that situations were found where pedagogical methods and attitudes had caused certain cognitive operations to disappear which had previously been exhibited. It has always been of conern to me that some teaching methods did not appear to help the learning process very much for many students, but the thought that some learning environments can actually extinguish cognitive progress which had previously occurred is very disheartening indeed. Incidently, in both instances where this occurred the operation which was affected was conservation and the places were Hong Kong (Goodnow, 1966), and Zambia (Heron, 1971). The decline was attributed to a combination of poor materials as well as poor teaching methods. Again, the point is that we need to know more than we do about the role culture plays in cognitive growth if we are to capitalize fully on the work of the pioneers of cognitive development.

IV. In Summary

My purpose in reviewing just some of the agenda awaiting us in the 1980's has been three-fold. I do not want to lead anyone to believe that those of us who have been working on the application of Piaget's work to the education of college students think the answers are all in; they aren't, but we have much to be encouraged about. And those of you who came seeking some immediate help for your instructional problems will not be disappointed. Just remember that we are only beginning.

In addition to wanting to avoid a know-it-all stance, I also wanted to suggest to you the marvelous opportunities for professional growth, recognition, and creative work which await you if you become serious about relating theories of cognitive development to college level teaching. There is no discipline in which original contributions could not be made. Perhaps in your schools opportunities for scholarly activity are no problem, but I must say to you that in the colleges where I have worked such opportunities were not plentiful because of heavy teaching, advising, and curriculum development responsibilities. However, working with improved instructional approaches provides the scholarly opportunity which most of us need <u>as a part</u> of our regular work responsibilities, giving us a way to express our own creativity and to exercise our own sense of curiosity. Here is a significant chance to become engaged in really important professional matters.

Finally, I have wanted to address myself particularly to my old friends and colleagues at Metropolitan State College in Denver who have already made such a good start on addressing some of the matters I have tried to raise in this presentation. I want to reassure them that just because I have moved to Minnesota I do not intend to give up my infamous practice of nagging them, whenever I get the opportunity, to stay with the work they have begun. Now is not the time to become complacent, to rest on the accomplishments of the past, to feel that the

STAR program and its various off-shoots are good enough. Leadership is still needed in this developing field, and Metro must continue to be at the forefront of the research and experimentation that is necessary. I hope that next year this conference can be reconvened and that more understanding, more progress, can be reported.

I know you are going to have a stimulating conference. Last night the doctors Killian and I were engaged in a very lively conversation in the bar next door about professional issues that we are currently pursuing. Suddenly a total stranger asked if he could sit in on the conversation which he had been overhearing from the next booth. He maintained that he could not believe that people in a bar were actually talking about things that mattered in professional life. I hope that each of you will have at least one conversation in the next two days that will be so interesting to you that you are really unaware of the many distractions that a place like this may offer. I also hope that I have raised at least one provocative question for each of you, provocative enough that you will be moved to go back to your work and begin planning the teaching experiment you intend to initiate next fall.

PROJECT SOAR

Jacqueline Hunter
Lester Jones
Harold A. Vincent

Xavier University of Louisiana, a small predominantly Black Catholic college in New Orleans, offers a pre-freshman summer program designed to help students make the important transition from concrete operational thinking to formal, abstract reasoning. The program, Project SOAR (Stress On Analytical Reasoning), is a joint effort of the Departments of Biology, Chemistry, Computer Science, Mathematics, and Physics. It was developed in response to an increasing awareness that a significant number of students entering college have not made the transition and consequently have little chance for success in mathematics and science.

The core of Project SOAR consists of 25 three-hour "laboratory" experiences stressing five components of problem solving: the ability to control variables, to use proportional reasoning, to use probability, to use combinatorial logic, and to recognize correlations between variables. Each of the experiences is designed to complement the concepts in entry-level courses and is conducted in an inquiry-oriented, open format. The core experiences are conducted in mornings over a six-week period. Afternoons are used to provide instruction in note-taking, vocabulary building, and learning to read critically and reason analytically. Afternoons are also set aside for field trips, career counseling, and socializing. Full-time instructors run the labs with the help of assistants, who are coached on Piagetian theory. The student/faculty ratio is low, about 7:1.

The six-week program is partially funded by the Kenan Educational Fund of the Southern Regional Educational Board and Title III (AIDP) Grant #OEG-0- 74-2530. In 1977 there were 57 participants, in 1978 there were 109, and in 1979 there were 113. Approximately three-fourths of the students in all summers obtained higher scores at the end of the program than they did at the beginning and a rigorous analysis indicates that these differences are statistically significant.

Teaching strategies developed from the program are also being incorporated into freshman and sophomore courses in math and science. Individuals interested in additional information should contact Dr. J. W. Carmichael, Jr., Director, Project SOAR, Xavier University of Louisiana, New Orleans, LA 70125.

Identifying And Developing Advanced Cognitive Skills Through the Composing Process

Paul D. Farkas

Most Piagetian courses have focused on developing basic skills in freshman courses. This is not at all surprising since the need for cognitive development is most obvious in students lacking formal reasoning skills. We err, however, if we limit Piagetian courses to the basic level because cognitive structures are not fundamentally different in advanced students. Advanced students are more sophisticated and operate at a faster rate than basic students, but they still learn by raising questions to direct the quest, gathering data to experiment with alternatives, and then either assimilating the data into the present cognitive structure or adapting their cognitive structures to incorporate the new experience. This experimental process is basic to all learning, but is most evident in the writing process, a process whose nature is an application of the experimental method. Because the composing process and the cognitive process are so interrelated, writing can be a tool both for diagnosing and developing cognitive skills.

First let's take a look at writing as a diagnostic tool. Look at the following writing samples:

A. We need to change the role of women. Women used to be able to hold factory jobs during the war and they should be able to now. A woman can do just about everything a man can do. In fact, women used to work long hours on the farm. Many women still work hard, but they do not get recognized. Men get all the attention even though women are equal. Cleopatra was a woman. So was Susan B. Anthony. Billy Jean King is as good as most men. Women must unite to get their rights.

B. The inequalities between men and women in 1979 are neither the result of overt prejudice nor of any inherent

> biological inferiority of women. Rather they are the result of cultural conditioning. Unwritten rules of our society assign certain roles to men and certain ones to women. Because one unwritten rule assigns domestic chores to women and professional chores to men, a few hundred years of conditioning leads some to believe that a woman's place is essentially in the home and a man's in the marketplace. The result is that some men and women raise cultural conditioning to the level of biological law. Once conditioning is confused with law, male and female roles become fixed. Then, if some men and women step out of their roles, some will say they are going against nature. Thus, we often hear the absurd argument that it is "unnatural" for a woman to be a manager of a business or for a man to stay home and clean house.

For most readers, "B" is more satisfying because it flows, shows relationships, reflects a mind capable of examining issues, and represents a more mature reasoning pattern. In "A" the connections between ideas are not clear; ideas do not flow. The reader is taken from one concrete idea to another. No distinction is made between fact and judgment, between example and the concept it illustrates. Yet if the reader fills in the blanks, sample "A" is clear enough. "A" represents what Piaget calls syncretistic reasoning, and "B" represents formal reasoning. Syncretistic reasoning, because it stems from a lack of knowledge and relationships, shows up in the writing process as an inability to process ideas in a linear, analytical manner. Listen to Piaget's description of syncretism and see if it doesn't accurately describe some student writing we have all seen:

> 1. Egocentric logic is more intuitive, more'syncretistic' than deductive, that is, its reasoning is not made explicit. The mind leaps from premise to conclusion in a single bound without stopping on the way. 2. Little value is attached to proving or even checking propositions. The vision of the whole brings about a state of relief and a feeling of

> security far more rapidly than if each step in the argument were made explicit. 3. Personal schemas of analogy are made use of, likewise, memories of earlier reasoning which control the present course of reasoning without openly manifesting their influence. 4. Visual schemas also play an important part, and can even take the place of proof in supporting the deduction that is made. 5. Finally, judgments of value have far more influence on egocentric than on communicable thought. (1955, p. 66)

Syncretism thus forgets about the reader and represents only one part of the communication process. What the examples illustrate is how the writing problem is basically a cognitive problem.

Problems represented by sample "A" are not solved by having students consult a handbook. A usage course may remedy some surface errors, but can do little to remedy a student's basic cognitive immaturity causing the sample "A" writing. Fuzzy thinking does lead to fuzzy writing, but the solution is not to teach clear thinking apart from the writing process, but rather to use the writing process as a means of developing the cognitive skills required ina particular discipline.

This may appear to be a case of pulling oneself up by the bootstraps, but the nature of the writing process confirms the written word's power not only to clarify a thought but also to generate one. Words in themselves not only carry the meaning of our ideas, but they also generate the meaning before they are uttered. Once uttered,they reflect back on the inner language process and set up a dialectical process through which meaning is generated and understood. The analytical searching for a word, the synthesizing of the words into a syntactical whole, and then the evaluation of the adequacy of the words is an activity parallel to the scientific

activity of raising a question, gathering data, finding a conclusion, and then evaluating the results. The writer writes out of curiosity (What do I have to say?), tests alternate verbal strategies (How do I say what I mean?), and then evaluates the adequacy of the verbal expression (How well have I conveyed my meaning?). In a real sense the writing process is a microcosm of the experimental method. Through induction we generate new knowledge each time we write or speak. For too long, however, we have led students to understand writing as something quite apart from general cognitive growth.

Writing as an application of the basic analytical process is thus a definite aid to intellectual growth of any student. For advanced students, however, the writing process leads to other skills beyond analysis, synthesis, and evaluation. For advanced students, whose analytical skills are usually pretty good already, writing develops what I call paradigm construction and self reflection on the cognitive process, two skills leading to high levels of intellectual activity.

Paradigm construction is a significant advancement in a student's overall intellectual development. In paradigm construction the student overthrows a habitual way of thinking, plunges into the mystery of linguistic exploration of an idea, and emerges with a new, self constructed paradigm. Students undergoing such an experience will often report, "This course has changed my life," or "I see powers within me I never knew existed." When students make discoveries like this, learning has moved from the realm of accumulating information to the realm of self directed growth. Education is no longer merely relevant; it becomes dynamic.

Paradigm construction does, however, require a considerable amount of risk taking. Asking a student to examine basic values is asking for real soul searching. Since the writing process is so bound up in personal identity, overthrowing old paradigms about the writng process must involve overthrowing certain self images. I personally feel that one of the greatest hindrances to students' self growth as writers is the self image bound up in rather static notions fostered by previous educational patterns. Most good students have been taught to behave, that is, to become skilled at repeating the paradigms of each discipline. As writers they have been rewarded by saying what was expected, and not what was really on their minds. As the educational system continued to reward their obedience, they grew in their ability to become detached from their inner voices. Most sense a frustration with this, but can't figure out why their writing is correct, but boring and obvious. I always try to point out to my students how their self image is part of the problem. They have been more trained to protect themselves than to reveal themselves in their writing. The analytical, academic, and argumentative mode certainly encourages this, and, I will admit, does have its place. But academic writing is not the only way to write. When I ask students to try assignments that bring out their inner self, I am asking them to confront their real identity and use it as a base for writing. I tell my students, "Let the writing process assist your personal growth. You have to have a certain amount of letting go before you can grow as writers." The advanced student is able to let go because

there is enough intellectual adaptability to cope with disequilibrium. The more a student can let go, the more he or she can grow. We sometimes forget that our best students are capable of taking intellectual risks.

Taking an intellectual risk is only possible when there is a capacity for self reflection, a key ingredient in developing writing skills because the writing process by nature is very introspective. Rsearch into the composing process has shown how mature writers behave diffenently from immature writers. Mature writers show a capacity to reflect on what they are doing, monitor their own process, and as a result make better decisions about their writing. Sharon Pianko (1979) confirmed that the difference between the mature and and remedial writer is the ability to reflect on what is written. Lee Odell (1973) saw the ability to formulate and solve problems as a prerequisite for writing well. Piaget himself stated in 1970, "Cognitive growth gives rise to linguistic growth." Odell in 1980 expanded his original idea by explaining how the writing process is intrinsically bound up in the learning process. Of course, the seminal work in language/thought relationships was done by Vygotsky in the thirties. Vygotsky spoke of the writing process as intrinsically analytical and requiring a high degree of abstraction. The abstractness of writing is, according to Vygotsky, the main stumbling block to writing development.

At all levels of development students must then grow cognitively through language. The cognitive growth is accomplished through linguistic growth because ideas, although possibly conceived apart from words,

cannot develop without words. Too often in advanced courses we assume that students have all the cognitive and linguistic skills they need. This is not quite right once we see intelligence as a changing capacity for adaptation instead of a fixed capacity to receive and process information. Traditionally, students have been labeled advanced because they have mastered the art of processing information. I would rather define the advanced student as the one more adaptable, more open to ideas, having more of the ability to form the "rhythms, regulations, and groupings" Piaget referred to in 1947.

Once advanced students are seen as having a high degree of adaptability, teachers can see the writing process in its dual function of teaching both reason and language. And I do not mean English teachers only. Any instructor concerned with real intellectual growth can use the writing process as a teaching tool. We've all heard that writing something out enables us to understandit better. We say it is so, but do not know why, nor do we know how to take advantage of the self teaching writing affords our students. Our main problem is that when we do require writing, we want students to perform routinely in doing reports, term papers, or essay exams which rather than providing students a chance to use language as a means of discovery, merely require them to systematize what they already know. Of course, there is value in systematizing what is known, but this is not the highest function of language. Advanced students have already had too much practice with routine information processing. What they need is more heuristic use of writing.

Heuristic use of writing is writing as discovery, using writing to explore a topic rather than to report information. Martin Nystrand (1978) distinguishes between the heuristic use of language and the explicative. In heuristic use the student is given a problem or is allowed to raise a question to be explored. Instead of reporting information on the problem, the student simply begins writing, jotting down any reflections that come to mind. At this generative stage the student may have little idea of where the exploration might lead, but must keep writing about the topic for ten to fifteen minutes. This will not produce any finished writing, but it will stimulate the flow of ideas by tapping the generative source, the right brain. Freewriting one's personal reflections is an intuitive and imaginative process rather than an analytical one. In most college writing we focus on the analytical explication of the intuitive and forget to stimulate the generative source. When the heuristic language use is neglected, the student never experiences the structuring of his or her own generative acts and as a result is denied the Eureka experience so fundamental to paradigm construction.

If this sounds rather mysterious, it is. Language, particularly writing is not only a means of communication, but a means of knowing. The very act of writing generates as well as communicates ideas. When a group of students become engaged in a heuristic writing process and share their insights, ideas and finished essays emerge in a manner nothing short of remarkable. My advanced composition students are always amazed

at what they can produce once they get into their inner flow of language and allow the words themselves to generate insights. This is not a phenomenon of an English class, but an exercise in human cognitive development of the highest order. The final structure of the ideas will, of course, depend on the discipline;that is a later stage of adjusting the writing to the intended purpose and audience. The creative act of intellect, however, is fundamentally the same for all genius. Specifically, the creative act is a discovery of a hidden likeness through metaphor or language which is always in a certain sense metaphorical. Jacob Bronowski (1956) explains the process very powerfully, "The discoveries of science, the works of art are explorations--more, are explosions of a hidden likeness...the great poem and the deep theorem are new to every reader, and yet are his own experiences, because he himself recreates them. They are the marks of unity in variety; and in the instant when the mind seizes this for itself, in art or in science, the heart misses a beat."

At this point you may rightly ask, "How can I get students to have explorations of hidden likenesses, to make significant discoveries?" A technique I use regularly is the informal journal. Students should be encouraged and even required to keep a journal of their intellectual progress during the course. The informal writing of the journal comes closest to approximating the inner speech processes underlying all communication, and puts the student in touch with his or her own cognitive and linguistic processes. After ideas have been sketched out in a journal,

the student can confer with a fellow student or the instructor to bring the spoken word to bear on the exploration. What is important is not to consider these journal entries as finished products. Instead they are the raw materials from which the student can draw ideas for later, more formalized assignments. The most powerful learning experience a student can have is to structure into communicable form a discovery made out of a deep personal interest. The student will not only remember such an experience forever, but will yearn for it again. Eventually the student will acquire a habit of mind that raises questions instead of seeking closure. Closure becomes but a framework within which to stimulate further curiosity.

Of course, encouraging heuristic use of language has its risks and difficulties. The main difficulty is the amount of work it requires of the instructor. There is no easy and unemotional way to get involved in a student's cognitive and writing processes. Teachers must spend time with students pointing out strategies for handling a problem, or in guiding the student to discover the strategies. Sometimes the departmental syllabus will not be covered, but this seems a very small price to pay for better quality cognitive skills. Must a student be limited to the confines of a syllabus? I would hope not. We may have to let go a bit and become less authoritative. For too long we have unwittingly beaten the creative life out of our students with our pedantry, our syllabuses, our textbooks, and our egos. If our students are to be explorers, so must we by raising questions even we can't answer.

Nothing more motivates a student to learn than to learn with the teacher. As we encourage more informal inquiry, we may find some of our cherished assumptions about learning, about student/teacher relationships, about course content rapidly deteriorating as students make discoveries more rapidly than we can fabricate structures. We may even have to value the independent growth of the student over the course itself.

To determine whether our courses are creative requires some hard self examination. Do present assignments ask students to make discoveries or merely report information? Advanced students do not need information reporting assignments; they will get the information they need anyway. Is it possible to substitute writing assignments for exams? Can the principles of the course be incorporated into a series of a strategies to guide a student in written assignments? This is a better approach than testing, for it enables the instructor to guide students to see the cognitive structures the discipline requires. We should know what it is like to think like an artist, an engineer, a physicist, or a sociologist. Let's let our students in on the secret by letting them see how our minds work. They can best do this by working along side of us , and we can best understand their process if we do our own assignments. I never realized how my assignments worked with students until I did them myself. One assignment that leads a student to discover the cognitive process of a discipline is the personal autobiography. Have students explain how their interest in the discipline developed over the years by having them write a personal intellectual history.

I began this presentation by challenging you to use writing as a means of diagnosing and developing cognitive skills. What I have proposed is not revolutionary. I am asking only to rediscover the basic human power of naming through language. We so easily forget the obvious. To speak and to write is to call into being. To use language is to know; to write is to refine knowing in a highly analytical way, to stop the stream of consciousness in time and space and discover the common principles of human life. All real learning is thus language learning, that is, the exercise of our power to call into existence through words. Language is the element most common to all disciplines. This is not to say that all disciplines must have a common language style. Instead, each discipline must develop its own language style, but we should not let the fixed phrases of our intellectual habitats obscure language's fundamental power to help us and our students know.

PIAGET IS NOT ENOUGH

Maureen P. Lancaster

Piaget has been discussed, puzzled over, debated, and sometimes we have attempted to apply his theories to our classrooms. Piagetian theory has become an integral part of our pursuit of the unanswerable questions: What is learning, and what can we do about it anyway? This paper is intended to explore the implications of the concept of development for education. What do we need to add to our conceptions of development if we are going to address human development in the classroom?

The underlying premise is that development is, indeed, the legitimate aim of education. Kohlberg and Mayer (1978) treat this issue very thoroughly in their article, Development as the Aim of Education. In summary, they contrast the developmental/progressive ideology of education associated with Dewey (1938) and Inhelder and Piaget (1958) with cultural-transmittal and romantic ideologies. The crux of the argument seems to be largely philosophical, stressing concern for the welfare of both the individual and the community. Cultural transmission prescribes the content of education based on the notion that transmission of relative cultural norms to produce a successfully socialized and productive citizenry is the ultimate goal of education. The behavioral learning theory (the impact of the environment on a largely passive individual) is the underlying learning theory. On the other hand, romanticism holds the freedom of the learner in the here and now to be the central goal, with little concern for future social consequences. The underlying learning theory is primarily maturational--the child should be allowed to develop in his/her own unique way without intervention. The developmental/progressive theory emphasizes the goal of a free, powerful, and competent person interacting with others with respect for human dignity, equal rights, justice, and liberty. It is based on the learning theory of interaction between the individual and the environment which can have either negative or positive future consequences for the individual and the community (Dewey, 1938.) It holds that the purpose of education is to provide experiences which lead to positive developmental experiences, which facilitate the progression of the individual through universal stages of development described cognitively by Piaget and in terms of ethical decision making processes by Kohlberg (1973). They point out that the values of progressive education are not imposed on the

individual because cross cultural studies show that the criteria by which moral judgments are made at each stage are universal, even though content of ethical issues may be culturally relative, and those who reach the highest stage of moral development universally value human life, dignity, equal rights, and justice.

Kenneth Benne (1979) adds to the argument for development as the major goal for education. He points out that in a society undergoing rapid change, the most critical role of learning is the creation of new and more effective ways of being human. This kind of learning only happens through dialogue, through exchange with others struggling to respond to the same issues. It is unlikely that these dialogues can be successful if the individuals involved have not reached developmental levels that allow them to identify, understand, and make decisions about complex issues.

Kohlberg and Mayer and Benne present convincing arguments in support of the premise that development is the legitimate aim of education, but what kind of development is at issue?

Piaget's work is primarily concerned with cognitive development--the movement from sensory motor to preoperative, to concrete, to formal abstract reasoning through qualitative changes in cognitive structures and processes--but there are many other developmental models of significance to the problem of being human. Lawrence Kohlberg (1973) has described moral development in stages very similar to Piaget's stages of cognitive development. He describes the process of making ethical decisions. The content of the decision is culturally determined, but the criteria used at each stage is universal, and in the most advanced stage of his model, individuals from a variety of cultures reach the same conclusions as to what is ethically appropriate. Kohlberg's model consists of three levels with subsequent substages. The preconventional stage includes three substages: judgment based solely on the individual's desires, avoidance of punishment as the means to good, and an instrumental exchange--be good to me and I'll be good to you. The conventional stage finds ethical decisions based on approval from others, and subsequently based on what identified authorities define as good. The postconventional level finds moral judgments based on carefully examined and negotiated social contracts, and finally through an autonomous process which defines universal and consistent ethical standards. Very few persons reach the last substage, autonomous decisions based on universal and consistent ethical standards. Martin Luther King is described by Kohlberg as one of the few individuals to reach

this last stage of moral development.

Jane Loevinger (as described by Arthur Chickering, 1978) has described still another stage developmental model for ego development. Interpersonal style, character development, cognitive style, and conscious preoccupation are included as descriptors of ego development. The stages (presocial, symbiotic, impulsive, self-protective, conformist, conscientious, autonomous, and integrated) bear a resemblence to both Kohlberg's and Piaget's models. For example, the conformist's character style is conforming to external rules, his/her interpersonal style is helping and belonging, the conscious preoccupation is appearance and social acceptability, and the cognitive style is simple, containing stereotypes and cliches. On the other hand, the autonomous person can cope with inner conflicts, uses self evaluation to set standards, is concerned with communications and respects autonomy in relationships, is concerned with self fulfillment and motivation for behavior, and exhibits conceptual complexity and tolerance for ambiguity. Similar to Kohlberg, she has found few adults (approximately 1%) who have reached the final level--the integrated stage, where they can integrate internal paradoxes and cherish the individuality of others.

Erik Erikson (1978) offers yet another model, from a different theoretical perspective, where the issues of young adulthood and adulthood are successively: identity vs. confusion, intimacy vs. isolation, generativity vs. stagnation, and integrity vs. despair. For him, the issue is not whether or not a stage will be reached, but in which direction the developmental issue will be resolved, i.e., whether or not the young adult will resolve to isolation rather than intimacy, or the older adult will choose despair rather than integrity.

Add to these recent researchers in adult development (Levinson, 1978; Gould, 1978; and Vaillant, 1977), and the picture is even more complex, to say little of those who have found that cognitive development may take different directions in adulthood, and perhaps continue beyond the last Piagetian stage (Long, McCrary, & Ackerman, 1979.)

There seems to be a correlation at least between Piaget and Kohlberg and Loevinger, but it is not necessarily a direct one-to-one relationship between the stages of the different models. Kohlberg and Mayer (1978) directly state that formal reasoning is necessary, but not sufficient, for advanced moral or ego development. If we are to be committed to development as a goal, then we must consider these other developmental domains. Facilitating

cognitive development is essential, but it will not guarantee development in other areas of the person's life. So we must concern ourselves with other models of development in the college setting.

The issue of application, though, is not a simple one. Major viewpoints concerning application are matching (matching the educational process to the given developmental level of the learner) or facilitative (facilitating growth within one stage or towards another.) Duckworth (1979) reviews evidence that shows that unless readiness is present in the individual, attempts at acceleration are futile. She recommends creation of opportunities for richer development of the present stage, and opportunities for movement to the next stage. Kohlberg and Mayer (1978) describe the issue as being avoidance of stage-retardation rather than stage acceleration; the concern is providing experiences which will prevent the individual from getting stuck, instead of pregressing at a rate appropriately unique to the learner. So, the resolution of the application issue seems to be insuring opportunities for growth at the level appropriate to the learner, but not attempting to force growth.

Several models exist for such facilitation. Arthur Chickering (1978) presents an admirable succession of teaching strategies appropriate for each level of ego, moral, and cognitive development. He points out that strategies and functions most commonly used by higher education (structured programs for predetermined competencies and certification through lecture, discussion, and programmed, mediated methodologies) are appropriate to the conformist and conscientious levels of development, while those goals and strategies appropriate to an autonomous level of functioning--asking key questions, posing dilemmas, confronting paradozes, and fostering personal experience and insight through self directed learning, a mode preferred by adults (Tough, 1971)--may be noticeably absent. An application model for Kohlberg's theory has been developed extensively by Galbraith and Jones (1976) and uses primarily discussion of moral dilemmas focusing on the reasoning process involved, rather than the content of the ethical decision. Mosher and Sprinthall (1970) are cited by Kohlberg and Mayer (1978) as having developed a model of application appropriate to, though not necessarily based on, Loevinger's model. They describe a high school psychology curriculum based on cognitive content and experiential learning through development of counseling skills, improvisational theater, teaching, small discussion groups that confront personal issues.

David Kolb and R. Fry (1975) offer a model of experiential learning that may be well worth exploration as a more generalizable and unified model

of development and application. The model consists of four distinct but interrelated ways of learning: concrete experience, reflective observation, formal abstraction, and applied experience. For the cycle to be complete, we affectively participate in an experience, reflect and make observations about that experience (usually including interaction with others), draw conclusions that are generalizable to other experiences, and test those abstractions through application of them to other experiences. This model is very similar to the learning cycle of Piagetian theory, with the addition of the affective element, and Kolb and Fry include development as part of the model. Usually, we develop learning styles that rely primarily on <u>two</u> of the four steps of the cylce. The tension (similar to Piaget's disequillibrium) between the four different kinds of knowledge (affective, perceptual, cognitive, and behavioral) leads us to resolution of the tension, and to <u>development</u> resulting in increased affective, perceptual, cognitive, and behavioral complexity. Would it be possible to facilitate experiences in the classroom that can challenge the learner's developmental needs on several levels and help him/her to become adept at using <u>experience</u> to learn and further his/her own development by using the <u>entire</u> learning cycle rather than selected parts? Learning to use personal experiences as a learning experience may be the core issue of lifelong learning.

Within the college curriculum, we might explore application of the various developmental models by either exploring the ways in which moral, ego, and cognitive development can be incorporated into single subject areas, or we may also want to explore the broader perspective of the general studies curriculum so that it can incorporate human development in a cohesive manner. We may even want to consider offering particular personal development courses dealing with psychological and social issues associated with Erikson, Levinson, Gould, Vaillant, and other adult developmentalists. Vivian Rogers McCoy (1977) has designed a comprehensive continuing education program built around adult developmental needs.

But, we are only at the beginning of understanding the relationship between learning, the educational system, and human development. We cannot jump in haphazardly, but must strive to synthesize, and understand, the relationships between the different developmental models, and continue to build our knowledge of development. Whether or not we choose to include developmental theories in a single course, or in the philosophy of an institution, and hence, in the institution, if we are committed to development as the

goal of education, we cannot stop searching for a comprehensive understanding of what development is, could be, and how it can be applied with integrity within the educational institution. Cognitive development is important, but it is not the only kind of development we should concern ourselves with. We must tend the spirit as well as the mind. We can't tend the mind alone and expect fully developed, fully functioning persons.

Piaget and Curriculum

Susan Hofmann

The purpose of this session is to discuss the relationship between Piaget, learning cycles and the curriculum. The panel members are faculty members from the STAR (Steps to Abstract Reasoning) Program who have used the learning cycle model in their content areas: Chemistry, Math, Philosophy and Study Skills.

During the 1977-78 academic year faculty members representing eight disciplines used the STAR program in at least one of their introductory courses. The results of that first year's programs are discussed in a Metropolitan State College publication entitled, "An Approach to the Development of Cognitive Skills: The STAR Program." Modifications have been made as a result of classroom experiences and research. Today's presentations will reflect the current state of the program.

Each participant will briefly discuss their use of learning cycles. The panelists will then be asked to respond to the following questions:

1. What influence has Piaget upon the curriculum in your area?
2. What effect does using the learning cycle model have upon the content of your course?
3. Can all content be put into learning cycles?
4. What limitations does each content area have when using learning cycle model?
5. What are the demands upon the faculty when using a learning cycle approach?
6. How have students reacted to the use of learning cycles?

Panel members, with discipline, were:

Stephen Benson, Philosophy

Armando Gingras, Mathematics

Sharon Hahs, Chemistry

Susan Hofmann, Moderator and Counselor

Maureen Lancaster, Study Skills

Richard Otto, Philosophy

DORIS: Development of Reasoning in Science, a Course in Abstract Thinking

Francis P. Collea

Susan Nummedal

Many Universities and Colleges are making inadequate evaluations of the logical thinking abilities of their students. It appears that most college courses have not taken into account the research on learning and intellectual development. Many professors make the assumption that their students can use abstract thinking skills in dealing with course content. Present research indicates that approximately 50% of college students can not use abstract thinking skills confidently and reliably in dealing with course content.

As a result DORIS: Development of Reasoning in Science, a Course in Abstract Thinking has been developed. Using the content of chemistry, earth science, mathematics, and physics as a vehicle, the following thinking skills were developed in the course: combinatoral logic, correlation, hypothetical-deductive reasoning, isolation and control of variables, and proportional reasoning.

In three semesters of evaluations, significant results have been obtained in developing the thinking skills of students enrolled in this one semester course.

BACKGROUND INFORMATION AND SUMMARY OF PRESENTATION

Thomas Campbell
Karl Taylor
Richard Thompson

Higher education in America is slowly changing to meet the needs of its society. During the past 20 years, education has moved from "Academic Excellence -- 1950's" and "Equal Opportunity -- 1960's," to "Faculty Development and Student Learning - 1970's." This shifting emphasis shows a definite progression from "education for the elite" to "education for all" and perhaps as Cross (1977) suggests, maybe ending with "education for each."

Institutions of higher learning, and especially community colleges, find themselves in a position of providing a responsible curriculum for an increasing number of individuals who come with diverse academic backgrounds. The open door policy has increased enrollment in two-year schools until roughly one-half of all college semester hours offered in this country are through community and junior colleges.

With the change in student clientele, educators should expect a change in basic skills which entering students bring to an institution of higher learning. Community colleges, colleges, and universities have developed new programs in an attempt to assist entering students, but most emphasis has been placed on remediation and on the development of special vocational degrees like nursing, engine power technology, electronic repair, etc. Most institutions have not changed their track baccalaureate degree programs.

In 1976, several members of the Illinois Central College faculty began to develop a new approach designed for incoming freshmen who were interested in pursuing four-year degrees. Financed by the Fund for the Improvement of Post-Secondary Education (DHEW), the program was designed to attract those who might be classified as marginal transfer students: those who had average or below average test scores and grades and who had been away from school for some time.

In other words, these were those students who were given a fifty-fifty chance of successfully acquiring a four-year degree, but who did not have any known deficiencies in reading or mathematics. Therefore, the new program, called DOORS (Development of Operational Reasoning Skills), was initiated in the Spring of 1977, but it was not designed for remedial students.

The content of DOORS is heavily based on the psychological studies of Jean Piaget and the educational theories of Robert Karplus. As Piaget and others have pointed out, the child, when moving from infancy to maturity, seems to progress through four stages -- from sensory motor and pre-operational to the concrete and formal levels of operations. Oversimplifying, one could probably say a person at the third stage -- the concrete -- learns a concept best while actually manipulating concrete objects. Research at Illinois Central and several other schools indicates that perhaps as many as one-half of all entering freshmen may be operating at the concrete level or at a transitional point between the concrete and formal. Thus, they have trouble grasping material which is presented in a formal or abstract manner like a typical college lecture. In order to meet the needs of these students, we have created materials and instructional methods for moving from the concrete to the formal. Robert Karplus' learning cycle has been especially helpful with its three stages -- exploration, invention, and application.

The DOORS Program is currently in its third full year of operation. Gathering evidence of its success, or lack of it, has been difficult. Our major objective concerned the enhancement of beginning college students' use of more formal thinking processes. Either through ineffective evaluative efforts, the shortness of the intervention period or due to a host of other uncontrolled variables, this result was not varified. On the other hand, the results do seem to suggest that DOORS students, even though they as a group are much less academically prepared, make as much intellectual growth as a typical group of community college students.

We have been very pleased with the extremely low attrition rate in the DOORS classes. Classroom attendance in DOORS courses is much higher than that in the traditional courses. We are also pleased with the number of DOORS students that continue their educational endeavors after leaving the DOORS Program. These results must be viewed from the fact that the great majority of DOORS students were classified as "marginal" transfer students.

One significant outgrowth of the DOORS Program has been the presentation of workshops which are intended to summarize and explain our efforts at Illinois Central College. The workshops are also designed to demonstrate how the ideas, mentioned above, are incorporated into classroom situations for participants who are provided with hands-on experiences.

About two hours is needed for the workshop, consisting of a number of activities for the participants. After a brief explanation, the participants are divided into smaller groups where they become involved in one or two activities demonstrating self-regulation -- Petals around the Rose and Mirrors Puzzles. Both require the participants to examine how they respond to a learning situation. After this experience has lasted for about thirty minutes, the workshop returns to the large group format for a short discussion of Piaget's learning theory. Following this discussion, the participants will be asked to join one of three groups led by one of the teachers in Physics, English or History. The purpose is to demonstrate classroom materials in those areas. If the participants select two classroom situations, this phase of the workshop takes about forty-five minutes. The workshop concludes with an eight-minute video tape, giving a brief pictorial view of the DOORS program and showing interviews with former students. Following the tape, participants will be able to ask questions about the workshop and DOORS.

The Adaptation of Cognitive Instructional Approaches to Working with Learning Disabled Students

Eva O. Dyer

During this two hour presnetation I would like to give a theoretical explanation of why the Adaptation of Cognitive Instructional Approaches to working with learning disabled (LD) college students at Metropolitan State College (MSC) has proven successful. To a great extent my discussion will focus on instructional approaches and not LD programmatic design and implementation, which is beyond the scope of this conference. However, I would like to initially discuss some aspects of our program design that will help you place our instructional approaches in better perspective, and I will be glad to answer questions about other aspects of the LD program organization during the discussion session at the end of my presentation or individually with you after my presentation.

During the 1979-1980 academic term, the MSC LD program processed over 150 students each semester with over 75 students involved in one to three elective courses offered through the English, math, and reading departments and taught by professional LD staff. LD students simultaneously took other courses required for a four year degree program. Our LD courses have included:

Language Structure and Grammatical Analysis

Elements of Written Composition

Reading in the Content Areas

Reading Strategies

Phonic Strategies

Spelling Strategies I and II

Vocabulary and Word Usage

Math Concepts.

Originally when the LD classes were designed, it was believed that their function was to operate apart from and supplemental to established classes. However, the classes have become, to a large extent, alternative forms of instruction for LD students which are taken in lieu of other classes. Let me briefly illustrate this.

At MSC students who wish to take a composition class register for English 099 and complete an essay exam to determine if they must go into English 100, which is an elective class designed to strengthen composition skills, or go into English 104, which is the hard-core English composition class required, along with the research English 102 class, of all students for graduation. We found that many of our LD students repeated English 100 several times without noticeable improvement, regardless of sincere effort on their part and excellent instruction from the teacher. Consequently, we felt that our course might function as a readiness class to allow students to succeed in English 100, after which they would complete English 101. We thought that the LD program would be effectively accommodating the needs of LD students if our classes could prepare students to enter and successfully complete English 100. However, we found that without exception, our LD students, after completing our Language Structure and Grammatical Analysis program, were able to go directly into and successfully complete with a "c" or better grade in English 101.

In reexamining the manner our LD program has evolved to meet the needs of LD students as a handicapped population defined by Voc. Rehab., Section 504, we found that:

1. The LD program must operate in close conjunction with the academic departments. The more regular faculty were involved in making recommendations for LD material development and the more LD program efforts were coordinated with instructional efforts in the regular classes, the more powerfully our courses could instruct LD students.

2. Since many LD students were on financial aid (e.g., Basic Educational Opportunity Grant) or were Veterans receiving VET funds that required they be full-time students, and since many of our students had families to support, requiring that they work twenty or more hours per week while taking classes, it was essential that LD students be permitted to earn credit for elective LD courses. LD students were best served if they were intensively involved in instruction to help them learn adaptive learning strategies. This was not possible if students, had to work on LD concerns in addition to taking full class loads.

3. In order to help LD students work as quickly as possible toward a four year degree, it was in the best interest of these students for LD classes to be alternative forms of instruction, using different means to achieve goals in established classes. In practice, all of our LD English and reading classes can be taken in place of other classes. The only exception ot this is the Math Concepts class, for which we are currently revising our materials so that it will become more fully an alternative form of instruction for LD students.

Using standardized, individualized tests, we have collected data on progress made by students. During the 1979-1980 academic term, students averaged in four to six months time:

2.6 grade levels spelling improvement ($2 < .01$)

2.4 grade levels reading recognition improvement ($2 < .01$)

2.93 grade levels math improvement ($2 < .05$)

1 grade level reading comprehension improvement ($2 < .05$)

Composition analyses indicated elimination of fragments and run-ons and other improvements that brought student performance within a 10th grade or above proficiency levels.

We are currently post testing students, and although we must wait for the completion of all testing beforeanalyzing data, the test results on the 3/4 of our students tested look promising. Only a few students have stayed at the same grade level and significant improvement has again been made by all other students in the academic areas tested. We are expecting greater improvement in reading comprehension, in particular, since we have refined our Language Structure and Grammatical Analysis program and designed our Reading Strategies Materials since the last testing. The results of the current post-testing is important because it will help prove that LD students are not regressing toward the mean, a common problem in using achievement score testing.

There are mamy variables to consider in evaluating why a program is successful. Certainly, program organization is important, as are quality of expertise, experience and personalities of professional staff, the extent to which the LD program is coordinated and accepted by other academic and special need components in the institution, and the support given to the LD program by the school administrators. However, I believe the academic gains made by LD students and the transfer of learning to regular classroom situations has been largely made possible by the cognitive instructional approach used in the materials that the MSC LD program has developed for its courses. These materials include:

The Language Structure and Grammatical Analysis Program

The Six-Syllable Program

The Vowel-Circle Program (Strong modification of the vowel circle part of the Auditory Discrimination in Depth Program)

The Word Usage and Vocabulary Program
The Reading Strategies Program
The Math Concepts Program

I will refer back to and explain samples of these materials later in my presentation. However, I would like to now explain theoretically why I believe the cognitive approach is a highly effective way to teach LD students.

I realize that not all audience members a familiar with the nature of learning disabilities. Therefore, I will try to briefly define and illustrate some specific LD problems as I move through the theoretical discussion. In addition I will hand-out an article that I wrote to explain the adult LD learner to faculty and other personnel at MSC. Although a talk on the adaptation of cognitive approaches automatically implies mention of Piagetian theories and concepts, it should also be understood that the cognitive work now being done the LD field has also been heavily influenced by research in cognitive behavior modification. I will try to integrate this theoretical information and attempt to explain how it can be practically used to instruct LD students and why it works.

Furthermore, let me mention that in developing materials for the MSC LD program, examination was first made of how efficient learners learn and then consideration given to how LD students deviated from this efficient learning. Cognitively based exercises were designed to allow LD students develop adaptive learning strategies to become more efficient learners. Based on a survey of the literature and my own experiences with LD students, there are hypothetical learning constructs that I accept as being true and on which the development of our materials are founded. For example, I believe that most efficient spellers can mentally juxtapose a visual image of the word, either the entire word or syllable-by-syllable, with its auditory (sound) equivalent. This mental juxtaposition is often not possible for LD students because of their learning disabilities. The question then becomes

how can we instruct the LD students to enable them, first, to become aware that this inability is creating problems in spelling, and, second, to consciously apply an adaptive learning strategy whereby the juxtaposition is made possible. We adhere to this approach of analyzing discrepancies in learning among LD students in a comparative manner with what is done by efficient learners and involving LD students in instruction to bridge the gap for all of our students, unless the learning deficits are so severe that only work emphasizing learning strengths can be used.

In order to better understand how cognitive instructional approaches are appropriate for LD students, let's examine two common problems experienced by LD students, perceptual and memory difficulties.

First, let's compare and contrast perceptual development among efficient students and the inefficient LD student. Harry Levin and Eleanor Gibson, in their book, Psychology of Reading, talk about efficient perceptual learning as,

> "learning to extract the relevant information from the manifold available stimulation, that is, the invariant information that specifies the permanent layout of the environment, the distinctive features of things that populate and furnish the environment, and invariants of events that enable us to predict outcomes and detect causes." (p. 13)

Stated another way, perception refers to the mechanism through which the individual recognizes sensory input or information and also refers to an ability to differentiate between simular but different sensory stimuli.

Gibson and Levin believe that three variables are critical to the proper development of perceptual abilities (pp. 36-45).

-- Increasing specificity
-- Optimization of Attention
-- Increasing Economy of Attention

The first variable, increasing specificity, refers to the fact that as a person matures, perceptions become increasingly differentiated and in more complete correspondence with the actual stimulus information. This increasing differentiation is needed to correctly perceive graphic features, phonemic differences, and to extract word meanings. As examples, perceptual problems can prevent the learning from achieving increasing specificity in each of the following areas:

Graphic Features (visual analysis of similarities and differences)

b vs. d
g vs. q
m vs. n

Show other examples of visual-perceptual problems

Phonemic features (Sound processing of similarit and differences in mind)

/b/ vs. /p/ (voiced vs. unvoiced consonants)
/t/ vs. /d/

frontal vowals ($\bar{e}$, $\breve{i}$, $\breve{e}$, $\bar{a}$, $\breve{a}$) (subtle difference in sound production)

Extraction of word meaning

Fine shades of meaning
Dual meanings

Second, let's examine the ability of efficient learners to optimize their attention. Efficient learners are able to ignore irrelevant material and actively and strategically use their peripheral sensory system to attend to relevant, important information. When instructing children, teachers deliberately use gimmics and devices to capture their attention. For example, elementary level basal readers use pictures and color to direct the child's attention to important information. However, when a person becomes a mature learner, we hope that the learner will be able to control and adapt his attention in a self-regulated manner in order to flexibly and efficiently explore new material.

For example, when trying to solve analygrams, the sophisticated adult learner does not use trial and error to mentally or manually manipulate the letters. Rather, the learner draws upon his understanding of sequential probability and letter clusters to systematically solve the anagram. Sounding out consonant clusters may be part of the strategy used. (Gibson and Levin, p. 57)

In contrast, LD learners with perceptual problems tend not to attend to critical variables while simultaneously ignoring unimportant stimulus information. This inability to optimize attention is evident in LD students who read word-by-word and understand the meaning of words separate from, rather than in combination with, other words. These students are unable to vary the "neurological" energy (i.e. their attention) expended to read sentences so that primary energy is given to important units of thought and secondary energy directed to less important words, phrases, and ideas. Students who cannot deliberately diversify the attention given to different components within the sentence, react to reading in different ways. Some apply the accelerator and use a greater number of RPM's to read each and every word in an attempt to concentrate on what is being read. More often, since operating at high speeds without changing gears soon leads to burn-out, the reader adjusts to reading in a less painful and frustrating manner

by consistently operating at low energy levels, attending to and concentrating on each word in an equal manner. Needless to say, reading becomes an exceeding boring, monotonous, and meaningless task for these readers. Or, if the reader does vary the energy level, it is done in a hit or miss fashion, which often means that a secondary or subordinate concept is perceived to be of primary importance, while the truly important ideas are relegated to secondary levels of concern.

In short, LD students who cannot optimize their attention tend to be passive learners who rely on trial and error rather than a deliberate strategy to learn. This inability is important to keep in mind when I later discuss how cognitive instructional approaches both forces the LD student to be an active learner and to use deliberate strategies to learn. (In the case of perceptual problems the student, through the use of cognitive instruction, will be shown how to use a deliberate strategy to differentiate critical elements of stimulus information, better attend to and become more economical in processing information).

Let's move on then to the final perception variable used by efficient learners, as defined by Gibson and Levin increasing economy of information. The efficient learner who increasingly becomes economical in processing information is able to detect and make use of the order and structure in the stimulus information in order to process and assimilate information more efficiently. To do this the student must flexibly move between using the smallest and largest unit of information needed to convey structural information. For example, during reading the student must flexibly be able to vary the size of units fixated on, moving from key words to phrases and more lengthy groups of words as necessary in order to efficiently "pickup" information (Gibson and Levin, pp. 43-44).

Specific learning disabilities prevent students from developing an ability to economically "pick up" information. For example, students with auditory reception problems are often unable to internalize rules and take advantage of structural redundancies in the language to enable them to fully comprehend what they hear and effectively understand what they read. Not surprisingly these auditory reception problems are often reflected in the student's written expression work.

Let's move on to briefly consider another problem that LD student's frequently experience, memory deficits. Although LD students exhibit significant variation in the type of memory problems that they have, many LD students frequently will score poorly on tests that require them to call back words presented or labels of objects viewed. Short term listening and visual memory is often a problem. For some students critical memory problems occur when things must be remembered in a sequence or set order. Other students may experience long term memory problems as reflected on general information tests. I mention memory problems because it is important, whenever possible, to de-emphasize the demands made of LD students to memorize information in a rote-drill, purely repetitive manner. Memory is simply not a strong mode of learning for most LD students. Yet, memorization is too often the primary form of instruction in LD programs. In the past the trend was to use task mastery instructional approaches with the intent that the student master a defined task by repeating the task often enough. Performance was charted using frequency tables over a period of time in order for the student to visually see his progress, an extrinsic reward which supposedly provided incentive for the student to persist in mastering the task. Unfortunately, the LD student's academic scores would decline after the summer's break. These students would forget what they had memorized in a rote-drill manner, since the use of pure memory is among the weakest ways to learn for most LD students. Therefore, it is of little value for LD students, for example, to use the task mastery approach

to learn the spelling words missed of the 1,000 most often used words. Instead, it is more fruitful for the LD student to apply an adaptive study approach that allows him to meaningfully attend to critical elements in the words, maximizing the specificity with which they perceive these elements, and economically and efficiently processing the order and structure of those variables.

Levin and Gibson write, and I quote,

> "As his economy of processing increases so does the child become aware of what he is doing, how he is controlling his own intellectual processes in an auto-regulatory fashion. He is learning, in short, how to learn on his own." (p. 86)

This is, in my opinion, an accurate description of what the efficient learner does. It is, unfortunately, something that the LD student does not do well because of learning disabilities, which are well-illustrated by the perceptual and memory problems described to you earlier.

How then do we help LD learners? What instructional approaches best enable them to learn? I have already mentioned that these approaches should be cognitive in format. But what is meant by that?

Referring to Piaget, let's briefly consider what the efficient learner is able to do as the learner progresses through the developmental stages defined by Piaget.

Sensory Motor: 0-2 years

--Child's thoughts based on actions -- need to be physically involved.
--Sense of purpose or direction is rudimentary.
--Stage is preverbal -- no language outside of names.
--Space and time concepts deal only with immediate time and space.
--Objects can be mentally represented.

Preoperational Stage: 2-7 years

--Operations or mental transformations cannot be performed.
--Can't think abstractly
--Language develops rapidly
--Thinking is non-reversible, static (unable to perform series of operations)
--Time concepts: Present, past, future.
--Space concepts: Yard, home, neighborhood.

7-11 years Concrete Operational Stage	11-15 years Formal Operational Stage
--Mental operations: Separating, combining, ordering, seriating, multiplying, dividing, repeating, substituting, reversible thinking, one-to-one correspondence. --At end of period, classifying, analyzing, measuring	--Perform hypothetical deductive thinking --Propositional thinking --Reflexive thinking --Synthesize information, resulting in new ideas --Imagine ideas --Understand probability --Question values and ethnics --Formulate theories --Time concepts: broadened to infinity; awareness of mulecular space and universe

I do not wish to elaborate on the Piagetian stages except to allow you to reflect, in a comparative manner, on the cognitive differences evident at each stage.

(relate back to 4 Piagetian stages)

--Perhaps the most noteworthy development during the pre-operational stage is the development of language.

--Toward the end of the concrete operational stage, the child is able to analyze, classify and measure. This represents a monumental leap in cognitive processing.

--The formal operational stage represents a tremendous change in the quality of cognitive processing with the individual being able to, in subtle and unique ways, abstract and reason.

The progression through one stage to the next is continuous and not static. As you are probably aware from other workshops in this conference, students may be in transition from one stage to the next, being formal operational on some tasks and concrete on others. It is also productive to involve students in exercises that enable them to become formal operational thinkers. In other words, the absence of the formal operational cognitive structure does not mean that the students lacks the potential to learn that form of cognitive processing. It is important to note at this point that LD students show great variability in their use of formal

operational modes of thinking because of their LD problems, often being able to display formal operational thinking in some ways and remaining concrete operational in other respects that often pertain to academic areas in which they have experienced much frustration and failure, making learning unpleasant. To better empathize with the disappointment and failure experienced by LD students when they try to learn, let's briefly consider how efficient learners progress through the different Piagetian stages.

The efficient learner begins in a state of equilibrium, already knowing something. The learner then interacts with a new situation or stimulus, which creates frustration or disequilibrium. But this disequilibrium is not defeating. Rather it generates within the learner a desire to learn something new so that equilibrium can be once more established. Therefore, the learner processes the new information which results in a modification of the learner's mental structure, once more permitting equilibrium to be reached. This process of self-regulation allows the individual to change and develop and successfully progress through the different Piagetian stages. Obviously students who are highly motivated or have many environmental precedents to challenge and take control of the learning of new information will have no problem adjusting to states of equilibrium and disequilibrium. In fact, this should be a pleasant, intrinsically self-rewarding experience, as is the case, certainly, with small children who display tremendous curiousity and desire to explore the world around them and learn. It is within all individuals to be naturally curious and interested in learning, and it is only through unpleasant experiences that one learns to avoid learning situations. This is very much the case for LD students. When they interact with new, academically-based situations, they remain in a constant state of disequilibrium because their learning disabilities prevent them from processing new information in a self-regulated manner. They, therefore, remain in a constant state of frustration which they come to understand as failure.

How then do we make learning a pleasurable experience for LD students? I believe the answer again lies with Piagetian theory. Piaget wrote,

> "Assimilation must be active. This, the goal in education is not to increase the amount of knowledge but to create the possibilities for the child to invent and discover"
>
> Furthermore, "...getting the student to arrive on generalizations of his own has value in addition to its transferability, its motivational value." (Gibson and Levin, p. 70)

In short, "discovering something" is intrinsically reinforcing and leads to good generalization of that learning to other learning situations.

When I worked at Arvada West High School, I was often asked how I was able to motivate high school students when I used few high interest, high motivation materials and emphasized almost pure skill development. My secret was very simple. I involved students in instructional situations in which they were in control of their learning and responsible for what they were learning. Furthermore, it is virtually impossible for a student to discover a concept or rule without being actively involved in the learning, thereby counteracting one of the problems in working with LD students who have perceptual problems -- their passivity.

Let me restate my point again. Getting students to arrive at generalizations of their own has transferability value and motivational values which are within the student. This position is antithetical to the primarily passive-mechanistic views of the American behaviorists.

To better understand how we actively involve LD students in learning situations through our materials and why our instructional techniques appear to be successful, I would like to refer to the literature on cognitive behavior modification. (CBM)*

---

* The summary of the Cognitive Behavior Modification research and related statements is taken from John Lloyd's unpublished paper, Academic Instruction and Cognitive Techniques: The Need for Attack Strategy Training (L.D. Research Institute, 164 Rugby Road, Charlottesville, VA 22903)

Critical attributes can be defined for instructional procedures using the cognitive behavior modification approach:

1. First, the learning is structured so that students act as their own therapist, trainer, or teacher through the form of self-treatment, self-control, self-guidance, self-monitoring, self-recording, or self-reinforcement. This does not necessarily mean that the teacher leaves the room, although taped records and other mechanical defices have been used. I believe it is important for the instructor to be present to guide learning; however, the student is actively put in charge and held responsible for the learning.
2. Second, the CBM approach emphasizes verbalization as an integral part of the treatment program. To a large extent the use of verbalization comes from Luria's work dealing with the control of motor actions through verbal behavior.

3. The CBM approach emphasizes the identification of a series of steps through which students go in order to problem solve. The plan of attack can be abstracted to a very general level in order to help guarantee transfer other situations or it can be a plan of attack used in a specific manner for a particular task. The CBM research emphasizes the use of a plan of attack designed by the instructor. It is my belief that we must go beyond providing the strategies for the student by enabling LD students to gain insight into the way they learn so that they can consciously generate adaptive learning strategies independent from the instructor. Remember, the goal of any LD program is to allow the student to be able to function independently from the program. The

Reading Strategies flow chart that I will show you shortly will, I believe, give you insight into how we go about doing this.

4. Modeling is a primary means of instructing the students.
5. The CBM approach trains students to delay responding and evaluate various alternatives. (Reference Kogans 1965 work on the reflective vs. the impulsive learner).

These five components are not mutually exclusive but interrelated and interdependent. The verbalization component, perhaps the most important ingredient, for example, is very much a part in helping students avoid jumping the gun and responding in an impulsive manner with the first answer that comes to mind; it also forces the student to monitor his work. The student may initially explain out loud what needs to be done and how it needs to be accomplished. Eventually, however, the self-talking becomes a covert process that is done mentally by the learner.

For example:

> "What am I suppose to do? I am supposed to do (this) and then (this) and then (this). Now am I doing it? Good, I finished and did it correctly." (Lloyd, p. 2)

I should mention at this point that our LD materials at MSC were developed independent from the review of the CBM literature that I am now presenting to you. However, our materials closely conform to CBM constructs, which offers a theoretical rationale as to why our instructional approaches have resulted in rapid gains for LD students.

Let me illustrate.

If LD students experience vowel sound discrimination or sould production problems, we introduce them to the Vowel Circle program, which takes anywhere from four to eight hours to complete, depending on the individual student.

This program allows students to discover kinesthetic and visual ways in which they can attend to critical elements in vowels that are alike and different. Students discover several strategies:

1. Student associates vowel sounds with key words
2. First, students develop increasing specificity in processing vowel differences and similarities. One strategy concerns how the vowels feel in the mouth as they are said, beginning at the left end of the circle and progressing around the circle. Students observe that the vowels move step-by-step from front to the back of the mouth until /aw/ is encountered, which is the most "back". From this point vowels progress step-by-step forward in the mouth, until /oo/ is reached, which again is most forward.
3. Students discover that vowels can be categorized into three groups according to the way that they look (based on mouth formation) when they are said. This categorization allows students to more economically process information. Labels given by students for these categories are usually "smiling", "open", and "round".
4. When supplementary reinforcement exercises are provided, the student's cognitive processing is monitroed by the instructor by having the student talk out loud. The instructor does not tell the student the right answer; rather the student must systematically figure it out himself. For example, the student may be asked to identify the vowel position on the vowel circle that represents the vowel sound in the nonsense syllable /bay/.
   An illustration of the self-talk process that might be used by the student is as follows:

   > Student says /bay/. Student then may momentarily experience confusion in processing the vowel sound in conjunction with the consonant sound. Rather than randomly pointing to an answer on the vowel circle in an impulsive manner, the student engages in self-talk to consciously consider various alternative answer and use a deliberate strategy to problem solve the right answer. The student might say,

"I am confused by the vowel sound -- I am not sure whether it occurs here or here on the vowel circle. Let me examine how it feels in my mouth. My throat is not open and my lips are not round when I say this middle vowel part of the syllable. Therefore, it must be a frontal vowel -- a smiling vowel. It is not as forward in its sound production features as /e/ and I can hear that it is not /i/. If I temproarily eliminate /b/, I have /av/. The key word that it appears to match on the vowel circle is /at/. Let's see if I'm right:

/bay/
/av/
/a/
/at/

Yes, /a/ appears to be the vowel that most closely approximates the vowel sound in /bay/.

In our phonic and spelling program, students discover six syllable rules:

Closed syllable

Open syllable

Vowel-consonant-silent e

Diphthong syllable
(first vowel long, second silent; blends)

R-combination syllable

Consonant -le syllable

Theoretically, it is impractical for phonics to be applied to spelling, since there are so many phonic rules inconsistancies and sight word exceptions. However, we have had good success without approach, and I always wondered why until one day a student offered the following explanation:

"You know, this is amazing. Before I bacame involved in your spelling program, I used to learn each and every spelling word as unique and different from every other spelling words. I've had these spelling problems so long and my memory is so poor that I was really skeptical if your spelling approach would help me. But now I am understanding what is happening in my mind. When I study spelling I now have a system, the six-syllable rules, to refer to. I refer logically and systematically to those rules, following the spelling study strategy steps that I discovered. When I refer to the six-syllable rules I am either accepting the rules because they

apply, or I challenge and reject them because they do not apply. But at least I have a set system to refer to, which really forces me to pay attention to many small details that I previously ignored and forces me to really react to the words

I think this discussion by the student, which is almost an exact quote, beautifully illustrates that the student can actively assume control of learning when he can, in his own words, analyze <u>why</u> a newly learned adaptive learning strategy works.

One way to help adults students gain insight into their learning processes is to allow them, through discovery exercises, to understand the concepts presented in the chart below. An understanding of what instructional approaches are being used and the rationale for the use of that approach is essential if the student is to become intrinsically motivated and if the learning is to generalize to other relevant academic tasks.

<u>Inductive</u>

Particular to general
(Learner is active)

Emphasizes meaning and relationships -- enhances transfer of learning

<u>Deductive</u>

(General to particular)

(Learner is often told; LD students tend to be passive, though often is not case for efficient learner)

(Formal Operational)
- Formulate theories
- Hypothetical, deductive thinking
- Question
- Synthesize

Analyze
Classify

(Concrete Operational)

<u>MEMORY</u> (illustrate by using the series of numbers to the left)

1 3 2 4 6 7 9

1. Associative
2. Mnemonic memory aids
3. Grouping
4. Rhyming
5. Rote, repetitive work

ADAPT Program

J. A. McShane

ADAPT, the oldest interdisciplinary Piagetian college program, offers a process model suggestive of promise and problems. The promise, shown in faculty productivity and numerous spinoff programs, lies in several features:

1. Funded intensive study for entering staff (originally seven established professors from seven disciplines; since 16 from 11 disciplines);
2. Acceptance of a common theoretical model which is the focus of a weekly staff seminar, under the moderation of a developmental phychologist;
3. Evaluation, including longitudinal studies, conducted by a professor who is not teaching in the program;
4. Dissemination activities (workshops, books, and papers in several disciplines);
5. Focus on the process of learning, common to students and staff; this process has four Piagetian elements: ongoing research, experience, social interaction and self regulation.

One of the problems with the program is that the concepts need constant refinement. For example, we use "formal" and "concrete" to characterize operations exhibited by adults thinking about problems, not to characterize competence, and in keeping with Piaget's interactional epistemological model, we consider "assimilation" and "accommodation" complementary aspects of an operation rather than value-laden terms for sequential processes. Two other problems are 1. despite occasional munificence from the University, ADAPT as a hybrid program has no ongoing institutional support, a condition that distracts the staff; and 2. where the jargon suggests "developmental" means remedial, and "concrete" and "abstract" indicate types of concepts rather than processing operations, advice of parents, teachers, and counselors puts marginal students in the program.

ASSUMPTION: LANGUAGE IS THE TOOL

Patricia Hale Killian

Language is the tool of the intellect. Piagetian theorists view language as indispensable to the elaboration of thought through symbolic condensation and social regulation (Piaget, 1970). Piaget concluded that language transforms thought by helping it to attain equilibrium by means of a more advanced schematization and a more mobile abstraction. "The more the structures of thought are refined, the more language is necessary for the achievement of this elaboration" (Piaget, 1968).

Although Piaget and others have observed that one type of this refined thought, reasoning in a hypothetical - deductive manner, develops during adolescence, adults have been found to function at any cognitive level including trial and error sensorimotor in various situations. Adult use of formal-propositional operations apparently occurs as occasional optimal performance (Piaget, 1960; Hooper & Sheehan, 1977; Lovell & Shayer, 1978). Given optimal conditions, which are extremely difficult to specify, adults are capable of formal, hypothetical-deductive reasoning. Arranging these optimal conditions has thus become a major task of educators who obviously use language as their main tool. But to confound things a bit, the language tool itself may not be functioning in an optimal way. That is, college level learners may not use language as their reasoning tool in the manner that their instructor uses it, although they may be competent to do so. Further, the instructor's language use may actually interfere with what is to be learned.

Some concepts from the study of language are pertinent here. In spite of Chomsky's expressed doubt about the reality of Piaget's developmental stages (Chomsky, 1968, p. 80), two concepts which Chomsky has developed seem most appropriate to the study of cognition. Chomsky makes a competence-performance distinction in language. Competence is a speaker-hearer's true knowledge of his language. Performance is the actual production of language in specific situations. It is assumed that observable performance does not <u>directly</u> reflect competence (Chomsky, 1965, p. 4). For example, spoken language contains numerous deviations from the rules: false starts, changes in mid sentence, incomplete phrases, and so forth. Competence, the underlying system of rules that has been mastered by the speaker-hearer and used to produce the actual performance, must be inferred from that performance. Obviously, every adult speaker-hearer has mastered and internalized his knowledge of his language. "That is not to say that he is

aware of the rules of grammar or even that he can become aware of them or his statements about his intuitive knowledge of language are necessarily accurate ... it is quite apparent that a speaker's reports and viewpoints about his behavior and his competence may be in error" (Chomsky, 1965, p. 8).

The second concept is the correctly rule-governed-acceptable distinction. Acceptable utterances or sentences are ones which are in some sense natural and immediately comprehensible and in no way outlandish (Chomsky, 1965, p. 11). A sentence may be grammatically correct, conform to all appropriate rules, yet be judged not acceptable. For instance, this nested sentence:

> The man who the boy who the students recognized pointed out is a friend of mine.

To put it politely, this sentence seems abstruse. It is decodable and correct however, but such forms are rarely if ever used.

Mindful of Chomsky's distinctions of competence-performance and correctly rule-governed - acceptable, let's look at language and hypothetical-deductive thought in the college classroom. There is the Piagetian influenced instructor whose task is to adjust instruction to each learner's present stage of cognitive competence. This instructor however observes only the learner's cognitive performance through the medium of the student's language performance (spoken or written). There are the students who may be cognitively competent in propositional operations but whose performances, again through the medium of language performance, do not reveal this competence to the instructor. In addition, there may exist instructor-learner differences as to what are acceptable performances in reasoning and language in given situations.

Like the embedded sentence above, some propositional operations may seem unacceptable even to highly competent reasoners such as conference attendees. Take for example, Piaget's commutative transformations on implication. Piaget calls the implication and its rule-governed transformations a formal grouping (Piaget, 1968, pp 96-97).

Implication= (P,Q) If P, then Q.

Transformations:

Negation = N(P, Q) If b not true, if P, then not Q.
Reciprocal = (Q, P) If Q, then P.
Correlative = ($\bar{Q}$, P) If not Q, then P.

These are formal level transformations. Mindful of these P's and Q's, suppose they are tried using some language examples.

A. Implication: Apples are fruits.

Negation: It is not true that apples are not fruits.

Reciprocal: Fruits are apples.

Correlative: Somethings which are not fruits are apples.

These do not seem a totally acceptable grouping. In fact, the reciprocal and correlative seem clearly outlandish. Suppose a more logically formal sentence structure is used.

B. Implication: If the sun is shining, then it is daytime.

Negation: It is not true that if the sun is shining, then it is not daytime.

Reciprocal: If it is daytime, then the sun is shining.

Correlative: If it is not daytime, then the sun is shining.

There still appears to be something unacceptable about the reciprocal and correlative. They really are formally correct but yet are not immediately acceptable. The two sample reciprocals could be made acceptable, assimilated and accommodated by modifying them such as: Some fruits are apples; If it is daytime then the sun may be shining (if it's not cloudy or raining, etc.). But the correlatives are completely incompatible with the implication and to use Piaget's terms, produce disequilibrium. One can still attempt to make cognitive sense, assimilate them, again by rewording: If there is not a variety of fruits, then there are still apples; If it is not daytime here, then the sun may be shining on the other side of the world. Such rewording and other possible attempts at attaining equilibrium are done by reference to experiences outside the rule-governed framework of communication and are not permissible. The attempt to make cognitive sense of this grouping probably parallels the reaction of students to some of our instruction. Some of what is presented, may be assimilated well as occurred here with implication and its negation. Another portion of instruction may be assimilated with effort as occurred with the reciprocal example. Some components of instruction may remain unassimilated as did occur with the correlative in the example.

Does this grouping example raise questions about the presenter's competence in formal thinking? Surely not. Does it raise a question about the presenter's formal thinking performance? Perhaps. Could the presenter's language use result in the confusion? If yes, is language competence in question? Again, surely not. Well, then is the language performance questionable? Possibly. Perhaps comprehension of the necessary vocabulary or usage of sentences was faulty. Surely not. That leaves language phonology and pragmatics to consider. But the

use of sound combinations could not be at the heart of this disequilibrium. Pragmatics then. Probably there was a presumption of a usage of terms and symbols which was not appropriate to this situation. That is, performance was incorrect in both language and formal thinking because of the presupposition that commutative transformations had to produce a group which reflected experiential truths.

Now that this hopefully disequilibrating experience has demonstrated that performance need not reveal competence and that judgments of acceptability can confuse instruction, how might the language tool be used to prevent or lessen similar frustrations for students? Unfortunately the answer is not an impressive one. Only tentative and few specific recommendations are now possible. Because the dynamic interactions of cognition and language remain to be specified, it is not possible to provide definitive powerful recommendations. Yet even if the interface of language and thought appears to be a relatively unexplored frontier, some recommendations are possible. For example, some language use as a conscious tool to help learners acquire new content by extending familiar cognitive structures can be suggested. The "Some" pamphlet, Section II, provides suggestions for this aim.

To explore one boundary of the frontier consider the following. Piaget (1967) writes that for adults transposition and anticipation influence perception. To foster perceptual accommodation by those cognitive structures language can be used to guide perceptions. In this picture visual cues are not always sufficient to allow all viewers to perceive two women.

Some people perceive an old woman. Some perceive a young woman. Some naturally perceive both. All are cognitively competent to perceive two. A volunteer who perceives both can verbally tell a second volunteer who perceives only the young woman how to perceive the old woman. That would be an example of language assisting perception. If this example is used in a classroom, it is informative for the first volunteer to tell in as descriptive terms as possible what s/he did in coping with the second volunteer and for the second volunteer to tell which spoken items were helpful and which hindered acquiring the new perception.

Some suggestions are also possible to help language be used consciously as a tool to help learners develop new cognitive structures for thinking about familiar content. The "Some" pamphlet, Section III, provides suggestions for this aim of instruction. For example, Luria (1976) investigated adult thought using the semantic grammatical and pragmatic components of language. Refer to the "Some" pamphlet Section III., D. 5, p. 5, for a summary of his findings.

In the area of Semantics Luria found that meanings may be assigned by categorical and situational features (p. 73).

Subject is given the series horse-sheep and the alternatives: camel-pail-house.

S: The camel goes here. The ones over here are animals. (Immediately designates category.)

L: Then the others don't fit in here?

S: Some of them do. You need the pail to water the animals. (Lapses into concrete thinking.)

L: But if you had to arrange them in some kind of order, which would you put together?

S: If you arrange them according to work, only the camel fits. The sheep doesn't fit because it's livestock-it's used for meat. (Narrows range of concrete grouping.)

L: Does the house fit in with the first group?

S: It does. If you round up all the animals you can find space for them in the house.

L: But if you put them in order which one would fit with the first group?

S: The camel. You have to line up all the animals and then you can lead them into the house. (Uses both categorical and situational thinking.)

Competence in assigning meanings to words must be presumed but the answerer's performance is judged unacceptable. Apparently different rules for what is the

correct use of "meaning" are being applied with the resulting performance acceptable to the answerer but not to Luria.

Another example involves obviously different meanings for the same term (p. 148).

> After a lengthy conversation about people's characteristics and their individual differences with an eighteen year old, the following question was asked: What shortcomings are you aware of in yourself, and what would you like to change about yourself?
>
> S: Everything's all right with me. I myself don't have any shortcomings, but if others do, I point them out... As for me I have only one dress and two robes, and those are all my shortcomings.

The answerer's competence in assigning word meanings must again be assumed but the questioner and answerer differ as to the acceptability of a specific usage. How might language be used to produce a more semantically acceptable performance in these two instances? Demonstrate more acceptable performance preferably through a peer; provide opportunities for the answerer to talk with others about how animals might be grouped; openly state the acceptable word use with an analagous possible classification such as vegetables; overtly state that words may have more than one meaning and provide examples; use words to help the answerer isolate significant attributes; ask answerer how he arrived at that response, agree and then demonstrate other alternatives.

In the areas of Grammar and Pragmatics Luria found that unacceptable rule-governed systems might be used (p. 108-109), when dealing with logical syllogisms.

> L: In the Far North, where there is snow, all bears are white. Novaya Zemlya is in the Far North and there is always snow there. What color are the bears there?
>
> S: There are different sorts of bears. (Failure to infer from syllogism)
>
> L repeats syllogism.
>
> S: I don't know; I've seen a black bear, I've never seen any others... Each locality has its own animals: if it's white, they will be white; if it's yellow, they will be yellow. (Appeals only to personal, graphic experience)
>
> L: But what kind of bears are there in Novaya Zemlya?
>
> S: We always speak only of what we see; we don't talk about what we haven't seen.
>
> L: But what do my words imply? (repeats syllogism)

S: Well, it's like this: our Tsar isn't like yours, and yours isn't like ours. Your words can be answered only by someone who was there, and if a person wasn't there he can't say anything on the basis of your words.

L: But on the basis of my words-in the North, where there is always snow, the bears are white, can you gather what kind of bears there are in Novaya Zemlya?

S: If a man was sixty or eighty and had seen a white bear and had told about it, he could be believed, but I've never seen one and hence I can't say. That's my last word. Those who saw can tell, and those who didn't see can't say anything! (At this point a young Uzbek volunteered, "From your words it means that bears there are white.")

L: Well, which of you is right?

S: What the cock knows how to do, he does. What I know, I say, and nothing beyond that!

The answerer's competence to use rules is obvious but he relies upon personal truth rules rather than the closed syllogism, a particular rule-governed grammatical system to make a deduction. He doubted the truth of the premises. Something similar occurred here during the presentation of the Piagetian communicative P, Q group example. Performance was unacceptable because of interference from another language component, pragmatics. Pragmatics includes the rules of appropriate use of semantics and grammar in a given context. Those rules are based upon presuppositions about the correctness of particular usages - which words are permitted to follow others in specific situations. In this instance what things might be done to produce a more acceptably rule-governed performance?

One might suggest that Luria say something like the following: A very wise old man was teaching in the village. He always spoke only the truth and he wanted others to think about what he said so that they too only spoke the truth. The wise man said (the syllogism). That would be a pragmatic use of language to help the answerer deal with the content of the syllogism. Other techniques to help the answerer use the closed system of the syllogism would be to provide opportunity for him to speak with others who do use the syllogism appropriately; draw analagous syllogisms about content with which he is familiar; state that words sometimes have very specific referents as in the syllogism and give examples. Thus the conscious use of language as a tool for thought depends upon observations of performance and then interpretation of that Performance as acceptable or not acceptable for various reasons. If those reasons can be identified, some decisions about sentence length, word meanings, verbal interaction in a context, discussion and writing procedures <u>can</u> be made. As the interface between language

and thought becomes more known, strong techniques for using the language tool will be developed. For now the major use of the language tool must remain a weak one, that of providing opportunities for students to talk and write about what they are learning.

Learning Cycles in Chemistry

Sharon K. Hahs

I have taught introductory chemistry for two years in conjunction with the STAR program at Metropolitan State College. Steps To Abstract Reasoning is an interdisciplinary experimental program for freshmen utilizing Piagetian-based learning in ten different disciplines; my course has been taught almost exclusively with learning cycles. Today I would like to share with you some of my experiences in this course, including examples of materials, student responses, techniques and adaptations, as well as my perceptions on the strengths and weaknesses of Piagetian-based learning as it applies to chemistry.

I have placed examples of three learning cycles which I use in my classroom around at various stations for you to examine. They are the Chemical Problem, Balance the Scales, and The Octet Game. I would like to turn your attention to the Chemical Problem. Students are asked to figure out what substance is in an unknown solution (one of five possibilities) by mixing solutions of the five possible substances and the unknown. Typical responses students give when asked to justify their answers range from "It seemed like Number 2," (concrete operational thought?) to "I tried all possible combinations of the five known substances with each other and with the unknown; the unknown reacted in all cases like substance Number 3," (formal operational thought).

Let us review briefly. Of Piaget's four stages of cognitive development, the last two are of concern to science educators, that is, the concrete operational stage in which students can perform such tasks as serial ordering, conservation of number and categorical classification, and the formal operational stage, characterized by probabilistic reasoning, combinatorial reasoning and multiple variable reasoning. One progresses through these stages by

the process of self-regulation, first experiencing disequilibration, and then equilibration. The Karplus learning cycle with its three parts of exploration, invention and application is intended to create the environment in which the student can undergo self-regulation, encouraging cognitive growth.

Let us now turn our attention to the process of self-regulation and examine it more closely. There are three factors involved in the process: (1) Experience. Encounters with the environment produce contradictions; these include physical experiences (about objects) as well as logical-mathematical experiences (about actions on objects, e.g., counting). (2) Social transmission, or in other words, language. It is needed in order to debate and to share ideas; through this interaction students are forced to examine and justify their own ideas. (3) Maturation. Mental capacity for processing information increases linearly with age; this would be important for younger students. Self-regulation as a process involves an interplay and balance among all three factors. As instructors we attempt to create the disequilibration and encourage the equilibration of this process. Points (1) and (2) above are very important. Within the sciences, and chemistry in particular, the laboratory is the ideal environment in which to increase the experience of students and to encourage shared debate. The laboratory program in our colleges needs to be re-examined; we should have students explore a particular concept in the laboratory before that concept is introduced in lecture. Instead of "fill-in-the-blanks" laboratory exercises, students need to explore materials and learn to handle ideas even when the experiments don't always work "properly."

In addition to providing a quality laboratory experience, there are other things we can do as instructors to encourage cognitive development. We must remember to build on the lab work, refer to it in lecture to reinforce concepts. We should also use demonstrations whenever possible, thus giving students additional experiences. The topics in a course should be ordered

from the more concrete topics to the more formal ones. How many of us begin our introductory courses with one of our most formal concepts--atomic structure? We should review the course text for expected reasoning patterns in each chapter or section as well. And we need to write our exams with reasoning patterns in mind. Don't always ask for "plug-in" formulas; ask for justification of answers or solutions that require the student to furnish more than one intermediate step.

Yet another approach is to create learning cycles that can be done outside of the laboratory--they do not all have to involve wet chemistry. I have used with great success a "pencil and paper" learning cycle on the concept of limiting reagent. It begins with recipes; given various amounts of the ingredients the students are asked to determine the amounts of "product" made in each case and how they arrived at their answers. Once the idea of the limit is grasped, we can go on to "chemical recipes" (which ideally can be tested in lab).

To create learning cycles is not an easy task. It probably seems obvious that if one can create the exploration phase, the rest naturally follows. If one first chooses the topic and then lists all possible related concrete experiences which students may have had, the exploration activities may suggest themselves more easily. The idea is to give an open experience, but not too broad, so that the student cannot go too far astray in working on his own. Then, of course, the invention is straightforward (it may well be the lecture you used to give), and the application is reinforcement of the concept (perhaps the problems you used to assign on that topic).

And finally, let us consider some of the strengths and weakness of this approach. The concern that perhaps is voiced most frequently is that this approach takes more time than the traditional lecture format. This creates problems with content. However, improved reasoning skills, both during the course in progress and on a long range basis, should more than compensate for any material not covered. Also the retention rate has been shown to be consistently higher in courses using the learning cycle format. There is also

the concern of what to do if the student gets the "wrong" answer. First compliment him if it follows logically from his data, then suggest further investigation which would contradict his idea and reinforce the main concept. Another concern arises in multi-section courses, where different instructors may not be willing to use the same technique, and/or the same instructor may not teach the lecture and lab. While these situations might be awkward, they can be handled. I might also add that it can be difficult to get started with this format--students are used to being "spoon fed" and are initially insecure. Given exposure to the approach, they respond enthusiastically.

In conclusion let me say that I have data which indicates that the students in the chemistry section of the fall 1978 STAR program progressed in their development of reasoning skills and had a higher retention rate than students in the traditional lecture course. However, far beyond this tangible data is the sense of rapport in the classroom, the interested students, learning to question what they are seeing and to reason through their results. The learning cycle model is a tremendous technique in the classroom.

THE SEARCH FOR MENTAL STRUCTURES:

REALITY OR RHETORIC

Darrell G. Phillips

To embark upon even a brief discussion of certain aspects of Piaget's work frequently produces the statement, "Don't bother me with all of that theory. Just tell me what to do in my classroom." Such responses, especially with regard to Piaget, amount to not only throwing the baby out with the bath, but include the soap, towel, bathtub and house as well. Perhaps Piaget's greatest contribution has been conceptualization of a coherent group of developmental mental structures and an elaboration of them. Neglecting these structures is to omit the basis and the uniqueness of Piaget's work.

That mental structures do exist is no more than an inference, yet Piaget has amassed an impressive body of research through which he argues for the existence of these structures. In publication after publication, performance on tasks has been explained in terms of either the presence or absence of particular mental structures. For Piaget, then, mental structures are entities which do exist in a very real sense.

Perhaps one of the best arguments for the existence of these structures is the manner in which the human mind transcends and explores far beyond given facts. Observation of a two-year-child, when given an unfamiliar object, provides numerous overt examples of trial, readjust, trial, rotate, trial, translate, trial, etc. The child subjects the object to a great variety of manipulations, some familiar and some original, and these manipulations are certainly not dictated by the object itself. There appears, then, to be something acting early in life which is more than just a collection or a collecting of facts. In like manner, adult thought far exceeds the factual data by such feats as reasoning in terms of propositions and formulating hypotheses. Facts are not merely stored; they are acted upon. The view that the human mind is no more than a repository of facts or an aggregation of conditioned responses does not begin to explain human intelligence, much less its accomplishments.

The development of spatial relationships is one of the many areas in which Piaget assigns major importance to mental structures. He argues that the mental construction of spatial fields and the relationships of the objects within such fields transcends a mere mapping or copy of sensory data. Some individuals, however, believe that ideas about space are no

more than a series of mental images derived from perceptions. This perception-oriented interpretation permeates most areas of education and is evidenced by the "see it and you'll know it" approach to teaching. Perceptual, or sensory, data are certainly necessary as starting points, but there are several reasons that perception alone cannot explain mental spatial constructions. For example, perceptions are relative: many objects appear to change shape when observed from different viewpoints. In addition, perceptions often provide false information: parallel lines (e.g., railroad tracks) appear to meet at the horizon, or an object appears larger than others because of its proximity. To view spacial structures as products of perception alone does not account for the numerous instances in which the human mind corrects or goes beyond perception. For example, how does an individual mentally place him or herself in a different position and then describe how objects, or a spatial arrangement, would look <u>if</u> the individual were in that position? How did Copernicus ever determine that the planets revolved around the sun? Was his deduction based upon perception alone?

Piaget defines a mental structure as a system of transformations. "System" is used in the sense that the structure, even though composed of various parts, functions as an organized and coordinated whole. Each part exerts its particular requirements (i.e., it structures the whole) while adhearing to the rules of the ensemble (i.e., it is structured by the whole). The term "transformations" denotes the dynamic, mobile aspect of these structures, and, at the same time, dissociates them from specified content. For example, a classification structure, once formed, permits the classification of a set of visable objects, or sets of non-present objects, people, events, etc.; even the classification of non-existent, hypothetical entities. In essence, then, mental structures are those mechanisms we use to manipulate, transform and interrelate given data.

For Piaget, mental structures are the principal constituents of intellectual development. His primary purpose in presenting tasks to thousands of subjects in interview situations has been to trace the development of these structures. Some individuals, however, have misunderstood or overlooked the primacy of mental structures, often relegating major importance to the tasks themselves. Such misinterpretation is understandable in an answer-oriented society, but it is tantamount to rejecting the very basis

of Piaget's work. Tasks dissociated from their ascendant mental structures often lead to improper presentation and incorrect scoring criteria, and thereby contribute to the conflicting results found in the research literature. Indeed, a task stripped of its overriding mental structure (i.e., its meaning) is nothing more than just another, albeit clever, standardized test item.

A complete enumeration of the structures investigated by Piaget will not be attempted here, but perhaps a brief list is in order. The following occur at the concrete-operational level: (1) the logical groupings (nine structures dealing with additive and multiplicative classification and seriation); (2) the infralogical groupings (twenty-six structures, eight each for topological, projective and Euclidian space plus two structures for time); (3) the additive and multiplicative number groups; and (4) the measurement group. In addition, it is necessary to add a conservation structure for quantities such as amount, length, area and weight.

At the formal-operational level the basic structures are the INRC group and the sixteen binary operations. Some of the additional structures are the combinatorial system, proportionality, probability, correlation, multiplicative compensations, multiple frames of reference, etc.

Measurement and Mental Structures

During the many years that Piaget has been investigating mental structures he has consistently used the individual interview technique. Simple objects are presented, and questions, or problems, about these objects are posed. In response, the subjects must interact with the objects, make decisions and then explain, or prove, the basis of their deductions. The subject's developmental level is determined by his/her interaction with the objects and the reasoning used to explain the various deductions. Verbal responses alone, particularly at the upper levels of development, are insufficient. Piaget states, ". . . on the basis of language alone we cannot tell whether an isolated statement is concrete or formal. To do so we must examine the subject's train of reasoning."* To assess mental

* Inhelder, Bärbel and Piaget, Jean. The Growth of Logical Thinking from Childhood to Adolescence. Basic Books, Inc., 1958, p. 280.

structures, then, requires more than an evaluation of isolated verbal statements.

In spite of Piaget's methodology, an examination of current publications by other authors reveals questionable evaluation techniques: tasks are being presented in individual interviews, but subjects are not required to explain their choices and the tasks are then scored by means of choice-only (guess-only?) data; tasks are being presented as written tests in which no "train of reasoning" can be judged; or finally, the responses are being reduced to no more than mere guesses by means of multiple-choice tests! These procedures may be evaluating something, but they are certainly not evaluating systems of transformations.

To investigate possible differences between methods of task presentation, this author conducted a research study in which over one-thousand elementary school subjects were tested. Approximately one-half of these subjects were given five tasks in an individual interview presentation. The remaining subjects were given the same five tasks, but in a classroom-group presentation which required written choices and reasons. The outcome of the study was unequivocal: the two forms of presentation produced strikingly different results. The written format responses often did not contain enough information to permit a valid "pass-fail" scoring determination.

With evidence that written responses to tasks were inadequate, the next step was to examine possible differences in various types of paper-and-pencil formats. In the Science Education Center at the University of Iowa we have been investigating, somewhat informally, various written-test formats when used with university students. These tests are not Piaget-related in any manner; they deal with simple science content facts and not with mental structures. The procedure was to construct two tests containing the same items, even the same wording, but to prepare one set of items in multiple-choice format and another set in completion (i.e., "fill in the blank") format. The same cover sheet was used on both forms and they were intermixed so that there was a random distribution in the classrooms.

Even though it was anticipated that the multiple-choice group would generate more "correct" responses, the differences were much greater than expected. An item by item comparison between the two formats revealed that

on two-thirds of the items students utilizing the completion format generated less than one-third the number of correct responses as did the students using the multiple-choice format. In addition, the group using the completion format accounted for less than 25% of the total number of items passed. The results on the two formats were so different that application of the statistician's "correction for guessing" could not bring the two sets of scores to within a reasonable range of one another. The conclusion is obvious: students must necessarily do better on a multiple-choice test; the answer is on the paper!

Piaget has invested many years in the exploration of mental structures; he has used consistently the individual interview technique, and it is fair to assume that he would have employed other techniques if they had been appropriate. To test for mental structures requires a probing of the subject's reasoning that, at this point in time, cannot be accomplished by means of paper-and-pencil tests.

Research Studies and Mental Structures

The opportunities for research with Piaget's framework are limited only by the imagination of the investigator. Studies to find new structures, to investigate a particular structure, to examine relationships among similar or quite different structures are some of the possibilities.

For example, for the past seven years, this author has been involved with ten different, but interrelated, studies dealing with the logical and infralogical grouping structure which occur at the concrete level. Some of the specific questions posed were: Could Piaget's results be replicated? In what order were the structures attained within a set of related groupings and between sets of disparate groupings? What were the relationships between the logical and infralogical structures?

These studies were carried out by means of individual interviews with elementary, secondary and college level subjects. The results, for the most part, supported Piaget's findings as to the order of occurence of the structures, but the data from the spatial tasks were surprising. Sizable proportions of secondary and college students could not do some of the seemingly simple, concrete-operational spatial tasks. Apparently

these spatial structures are being formed either very late or not at all. Further research is being planned to investigate this and related problems.

Even though Piaget has provided a rich framework for research, few of the studies in the current literature have taken advantage of this fact. The typical study reports data from several, often totally unrelated, tasks and the investigator does not allude to the overriding mental structures in any way. Apparently such studies are conducted without any theoretical framework and their major purpose is to find the number of subjects who can give correct answers. (An analogous situation would be the physicist who places a number of different objects in a nuclear reactor just to "see what will happen.")

Observational studies, or status reports have their place; often they can indicate possible relationships or variables for further experimental study. But it does seem that in the Piaget-related literature there has been an overabundance of studies with no theoretical framework. The fact that an investigator uses Piaget-type tasks does not insure his/her functioning within a theoretical framework; many things occur in such a void --- standardized tests, for example.

Before accepting the results of any Piaget-related research study the reader would be well advised to examine carefully the method of data collection (interview or written test), the scoring criteria (reasons required or not), the task equipment and the questions asked by the investigator. In an above average study, there would be evidence that the author was aware of the mental structures that the tasks were testing.

Mental Structures and Educational Applications

If educators ever become aware of the richness of the pedagogical possibilities of Piaget's work, then there could be some genuine changes in the educational system of this country. There are, however, in my opinion, at least four steps (or should they be called stages?) that must be taken before any real applications can occur.

I. An Understanding of Structures

A thorough knowledge of mental structures including their properties and sequence of development is, of course, necessary. Perhaps the first

step is the realization that structures are not tasks nor are they content facts. For example, a classification of plants, Newton's laws of motion, and Einstein's relativity are not mental structures; it is incorrect to label content as either "concrete" or "formal." An analysis of a particular content topic in terms of the mental structures required to deal adequately with that topic is a correct procedure. But such analyses are needless if students are required only to ingest facts -- such memorization does not require mental structures.

As an individual attains a knowledge of mental structures, the variety and richness of ideas become apparent. For example, within the area of classification alone, the knowledgeable teacher or curriculum writer would be aware of the following: (1) to be engaged in classifying students must determine the classification criteria for themselves; criteria determined by others (e.g., the teacher) permits no more than following directions; (2) at the pre-operational level, students must have numerous opportunities to sort, arrange, relate and make designs with many different types of objects (graphic and non-graphic collections); and (3), at the level of concrete operations, the students must be engaged in activities dealing with hierarchical classification (asymmetric addition of classes and class inclusion), activities dealing with vicariant classification (symmetric addition of classes, i.e., classifications and reclassifications on the same level of hierarchy), and activities dealing with the use of several criteria simultaneously (multiplicative classifications which produce matrices).

II. An Acceptance of Responsibility

If educators accept mental structures as the primary components of intellectual development, then there must be an acceptance of the concomitant responsibility: to provide students opportunities to develop these structures. Some teachers can and have realized this responsibility, but it seems that the number of these individuals decreases as one moves from the elementary-school level through secondary to the college level. The pressure, particularly at the university level, to transmit the subject matter (that is, for students to memorize facts) appears to overwhelm all other considerations. The attitude evidenced by the statement, "It's too

bad the students don't have those structures, but it's not my responsibility to teach them how to think", is unfortunate indeed. The content facts within a given course may be logically related, exciting and extremely important (to the professor, at least), but without the requisite mental structures the students can only memorize (and then forget) what is, to them, a group of logically unrelated, therefore dull and unimportant, facts.

III. An Emphasis on Action

Upon acceptance of the importance of mental structures and the accompanying pedagogical responsibility, the next step becomes classroom application.

According to Piaget, an individual builds structures by drawing abstractions from his/her own actions on objects, not by observing someone else act on objects. This means that structures do not come from people or objects, nor do structures come from actions on objects; structures are built of those relationships, etc., that are derived (i.e., abstracted) from the individual's actions on objects.

That a student has objects and is manipulating those objects does not guarantee that abstractions are being drawn from the manipulations. And this is precisely the point which the writers of the "new" mathematics and many of the new science programs failed to comprehend. Objects were given to students, but the students were told precisely what to do with those objects; this effectively subverted possibilities for the construction of structures. Even those programs that allowed students time for exploration ultimately capitulated to the content facts; students learned quickly that the results of their explorations were unimportant, that the teacher would eventually tell "the" answers.

Finally, objects are necessary and actions on objects by each individual are necessary. But these are insufficient without the final step -- freedom.

IV. An Allowance for Freedom

This fourth, and last, step is without doubt the most difficult point for educators to accept. It is also the most crucial step for the development of mental structures.

No human being can determine or predict precisely another individual's mental strengths and weaknesses. Furthermore, no one can predict what another individual needs at a particular point in time in order to build mental structures. The uniqueness of each person's developmental level precludes lock-step, group presentation of objects, activities or content. Therefore, to permit the building of mental structures, students must be allowed to choose from a variety of activities (thus adding interest), begin the investigation at their own starting point, pursue the investigation in directions of their own choosing, and, finally, end the investigation at the limits of their ability. Piaget has stated these points succintly:

> . . . an experiment not carried out by the individual himself with all freedom of initiative is by definition not an experiment but mere drill with no educational value: the details of the successive steps are not adequately understood.*

Contrary to what some might believe, it is possible to conduct elementary, secondary and university level courses within the requirements outlined above. The students can choose from topics or investigations within the particular content area of the course. Experience has shown that effective instructors in such courses must be cognizant of the mental structures necessary to deal with the course content, and they must accept the diversity of starting points, sequences and goals that the individual students ultimately require. This is, perhaps, the most difficult method of teaching, but it is the most rewarding.

Mental Structures, Mental Structures, Wherefore Art Thou?

Some educators in this country have recognized the importance of a structuralist approach to education; that mental structures are the vital aspect of intelligence. Other educators, however, have been unable even to grasp the distinction between content facts and mental structures, or the relationship between the two. This disparity in comprehension has been evident in the diversity of attempts to apply a structuralist approach to the classroom. Some programs have made notable contributions, while others,

---

* Piaget, Jean. "A Structural Foundation for Tomorrow's Education." Prospects, II (1), Spring 1972, p. 19.

in spite of good intentions, have reverted to the memorized fact as ultimate goal.

Even though a structuralist approach could provide a rich basis for change, there is little evidence that such change could occur in the educational system of this country. Most present day classrooms are little different than those of the medieval universities. There are some differences, of course: the buildings are more comfortable; the students are healthier; and, there are books. But the primary emphasis, the transmission of facts, has not changed in hundreds of years.

Some individuals have grasped the significance and potential of a structuralist approach to education. They have surpassed mere rhetoric and are attempting to deal with the difficult realities of application. Someday, perhaps, students will be given opportunities to build mental structures and thereby develop intellectually. But at this point in time, as one journeys from classroom to classroom, there is the recurring image of Diogenes and his lantern ---- searching.

Interviews of College Students

Elizabeth Carpenter
Robert Fuller

A videotape presentation demonstrates how college students' reasoning may be elicited in the context of a Piagetian "clinical interview" situation which provides not only an occasion for the instructor to investigate the range of students' operational reasoning abilities, but also an opportunity for the students interviewed to have a positive learning experience.

Students' reasoning strategies on the Floating/Sinking Objects Task, as well as on the Equal-Arm Balance Task, show that their views of the way things work are consistent with their proposed answers to the problems, thus even when their answers are "incorrect," they are logically led to them by their world views. Some examples of disequilibration and self-regulation are included in these tapes, as are some cases of assimilation of language to inappropriate schemes.

The Learning Cycle in Physics

Jerry H. Wilson
Gerald O'Halloran

Experience with learning cycles in physics is discussed, with consideration of the effective use of a key word list to prepare short learning cycles. Some of the ideas tried by the authors to help save time in constructing learning cycles in physics are presented.

The Learning Cycle in Earth Science

Elizabeth Friot

"Introduction to Earth Science," taught in the STAR Program, is organized around the following topics: 1. What evidence do you have for what you know? (study of minerals and rocks, direct observation; study of topography, direct and indirect measurement) 2. What level of confidence do you have in your evidence? (study of earth motions, solar system, universe) 3. How do your belief systems influence your knowing? (study of earth history, study of the origins of the universe)

Information concerning each topic is garnered using the Exploration/Invention/Discovery cycle, and learners analyze their new information, asking the above questions.

The Role English Teachers Can Assume With Piaget

Avalon Williams

Teachers of composition now understand more about "creativity" in the composing process, and thus, can now interact with teachers in other disciplines to effect students' cognitive processes. Teachers of Piagetian-based courses are the most logical group with whom to interact. The essential, and continuously perplexing question is how to overcome traditional assumptions about writing, and the teaching of writing, to allow "content course" teachers to become more active participants in applying a variety of writing skills as an integral part of the learning cycle. Students would benefit from the results of the interaction since they would find that writing is a tool to be used in the learning process in all areas of the college experience.

PIAGETIAN STAGES WITH EMPHASIS ON FORMAL OPERATIONS: THE ROLE OF LANGUAGE

Myra O. Bookman

As a result of the humanist revolution of the sixties, there is a qualitatively different student entering college now than there was a decade ago. This is particularly evident at the urban center where individuals who are ill-prepared to solve the "academic problem" are flocking in great numbers under open admissions policies. Whether these difficulties are steeped in extrinsic (environmental) or intrinsic (learning disability) factors, there is one pervasive manifestation - disorders of expressive written language. They can't write!

While this indeed reflects a content problem, it is, at the same time, a symptom of an underlying inefficient thinking process. Examination of the Piagetian epistomological stance and the position on the interdependence of thought and language it necessitates, supports the use of language and language teaching as a vehicle through which we can provide awareness of the cognitive processes necessary for success in college. An overview of the Piaget model will be given, followed by some thoughts on the language/cognition issue, concluding with allusions to selected research which suggests the role of language in mature thought.

Basic Epistomology of Piaget

Rather than viewing Piagetian theory in isolation, it is instructive to consider it relative to other major philosophical stances. The two most pervasive schools of thought, empiricism and rationalism, have spawned a debate which has survived over decades. Each of these orientations necessitates a particular epistomology, that is, a theory of the relationship between a knower and what is known, which in turn dictates a given psychological and linguistic model. Each of these orientations will be discussed in turn, followed by a description of constructivism into which the Piagetian model fits.

Empiricism is essentially an environmentalist position which holds that all knowledge is evidence of the senses. It is posited that, in fact, there is no

knowledge before sensory data is gathered. No knowledge exists at birth; environment and experience are the sources of knowledge. This reflects the "tabla rosa" or blank tablet metaphor introduced by early empiricists. Inherent in this view is the learner as a passive organism and the notion of additive properties of elements to form a whole. Empiricism is said to have reached a debased form through American Behaviorism, the psychology upon which much of today's educational practice rests. This basic "stimulus-response" (S-R) interpretation of learning accounts for no active participation of the learner and supports an atomistic approach to learning steeped in disecting it into discrete parts. Language learning is seen as an accumulation of associations built through experiences with connections between given words and their corresponding events or ideas. Although oversimplified here, empiricism and its offspring behaviorism account for knowledge without benefit of mentalism, that is, inferring of hypothetical intermediary constructs between stimulus and response. Research is bound to that which is explicitly observed and confirmed.

The antithetical stance to empiricism, known as rationalism, posits prior innate organizing knowledge which meaningfully arranges all incoming sensory data. Certain rational principles are said to exist in the minds of all humans, an a priori understanding through which input is interpreted. Immanuel Kant epitomizes the rationalist view arguing that there is something more than experience alone that accounts for any individual's knowledge and these are the "logical functions" of the mind. Gestalt psychology is of this persuasion, which posits an innate ability to perceive the wholeness of forms as is the linguistic approach of Chomsky, which argues for a "language acquisition device" as a built-in mechanism to facilitate language learning. This stance emphasizes the importance of patterns of "wholes" rather than the additive sum of parts, as well as innateness of structures.

Beyond these accounts on the nature of knowing, Piaget (1971) proposes a third alternative, constructivism, or operational structuralism, in which ". . . logical procedures or natural processes by which the whole is formed are primary, not the

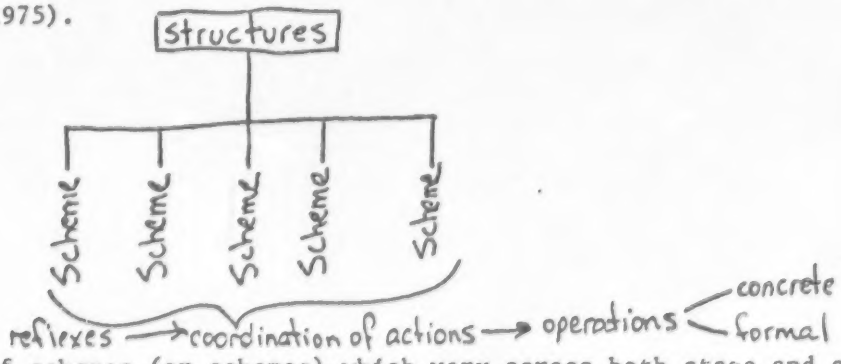
whole . . . or the elements" (p. 9). This is not a theory of simple additive interactionism, but one which posits the necessary requirement of active regulation between the environment and knowledge by the knower. The organism, in fact, constructs reality with qualitatively different cognitive structures at various levels of maturity. This self-regulation is an adaptive mechanism consisting of the building of abstractions from experiences, both physical and social. While an internal propensity toward equilibrium "pushes" self-regulation into action, maturational level constrains its form. Thus we have the foundation for the Piagetian Stage Model.

Prior to discussing the stage model, however, it is necessary to address the language/cognition issue in order to see how language teaching can most usefully be integrated into a Piagetian framework. There are numerous logical possibilities of manners in which language and thought may be related. A few of the most prevalent positions will be briefly described based on a review by Bates, et. al. (1977), for perspective on the view supported here. The first position is that language and thought are one in the same (L = C) and that studying them separately is pointless. In this view thought is interpreted as subvocal speech and it is held by many in the behaviorist school, while Chomskians support the independent development of these systems ($L \downarrow \quad C \downarrow$). Another popular orientation is the Whorfian perspective that non-linguistic concepts are somehow dependent on language, that we organize our world through language ($L \leftarrow C$), read as "cognition entails language," where arrow = entailment in the logical sense. The antithesis of this is that language depends on thought ($L \rightarrow C$), where Piaget is often placed. However, he is more appropriately placed in another position, symbolized as $L \searrow_{0} \swarrow C$ where language and cognition are felt to have a common operative source and one is not necessarily the prerequisite of the other (Bates, et. al. 1977). Current research suggests that while certain cognitive and analogous linguistic task successes emerge in development at the same time, directionality is not implied (cf. Bowerman, 1978).

In other words, these attainments are a manifestation of a common underlying structure, one not necessarily "causing" the other. Examples of this are symbolic play temporally coinciding with use of linguistic symbols (Bates, 1979) and ability to nest cups of graduated sizes, emerging when embedding of thoughts in language develops (Greenfield, cited in Bowerman, 1978). Research with the language impaired supports this view, as well, in that this population demonstrates deficits in symbolic activities other than language while remaining cognitively intact in other domains (cf. Leonard, 1978). Language and concepts, then, can be seen as a two-way mapping system, commonly steeped in one procedural base, the nature of which is described as part of the stage model.

Stage Model

It is necessary at the outset to define the nature of the Piagetian stage model itself, as well as the terms used for its components. The model is hierarchical, that is, stages are continuous and in logically necessary sequence, but not embryonic as are Freudian stages which are extrinsic and arbitrary - unfolding maturationally over time. Terms are best defined by showing their relationships through a figure adapted from Phillips (1975).



Structures are made up of schemes (or schemas) which vary across both stage and content. Adaptive self-regulatory mechanisms "push" for new schemes when old ones are found insufficient.

The nature of schemes and the way they are coordinated constitute the formal aspect of each stage, while the type of object operated upon makes up the substantive

aspect. These will be enumerated here only briefly, based on the assumption that the reader has been exposed (probably overexposed!) to the characteristics of Piaget's stages and their corresponding tasks. The earliest phase of human cognitive development, the sensorimotor state, is characterized by a logic of action (simple actions and coordination of actions into systems, e.g., grasping) which operates on real world objects (rattle). Toward the end of this period the child begins to create a new object: the mental object (representation). This is the time when linguistic forms begin to emerge and marks the transition into the preoperational period in which the operations of the sensorimotor phase are "tuned." The child can now abstract invariances to form "heaps" and "complexes" (Vygotsky, 1962), but not "true classes" based on intersects of features, nor can he/she see classes as forming systems. Reasoning is transductive, egocentric and perceptually bound, which is reflected quite distinctly in the language of this level (Piaget, 1926). Between the ages of 5 and 6 we see a qualitative shift into more "reasonable thought" as the child moves into concrete operational thinking. Classes of objects begin to form systems and he/she now uses quasi-logical operations to see the simultaneous subordinate and superordinate relationship of one member and the reversibility involved in conservation. These operations can be translated into set theory, but do not meet the criteria to be formalized using "true" symbolic logic which is the exclusive domain of the next and final stage, formal operations.

Our infant, having undergone quite a metamorphosis, is now a preadolescent and begins to use a thought structure not unlike formal symbolic logic to deal in the hypothetical. He/she is no longer bound to the actual or concrete reality as he/she was in concrete operations, but now contemplates the possible and pits it against the actual. Formal logic operates on propositions which constitute the substantive aspect of this stage. Structured thought is used, not trial and error, and can be modelled using the symbols of propositional logic. Using 16 BINARY OPERATIONS, logical relations among all factors p and q are determined. In other words, all

combinations of two propositions can be hypothesized based on two possible (binary) values of p and q (+ or -). Simple combinations are conceived much as they are in concrete operations such as $(p \cdot \bar{q})$, and combinations of combinations are considered which are exclusive to formal operational thought, such as $(p \cdot q) \vee (p \cdot \bar{q}) \vee (\bar{p} \cdot q)$ where $\cdot$ = and, $\vee$ = or, and $-$ = not. These sixteen functions are further transformed using the INRC group: identity, negation, reciprocal, correlative. Such operations are the formal aspect of this stage, while propositions are the objects operated upon. The formal operational individual, then, is expected to begin with the hypothetical and test out all possible imagined results against reality. This procedure "frees" the student from the limitations of building from the particulars in his/her reality (empirico-induction) to manipulation of the possible (hypothetico-deduction) which facilitates success in the academic arena.

Discussion and Conclusions

Some general reflections on the Piagetian model are in order here, particularly those germane to formal operations. Such overall comments drawn from several prominent secondary sources on Piaget (Ginsberg and Opper, 1969; Phillips, 1975; Flavell, 1977) will be reviewed along with the implications they suggest to me for teaching language to the college student:

1. Our discussion of formal operations should not imply that adolescents should be taught formal logic or that they know it in any explicit way, rather that this is simply Piaget's way of symbolizing the structure of his/her thoughts.

   The language system is the most similar tool that the adolescent or adult learner has at his/her disposal for creating and manipulating propositions. Since language is used to code and organize information, it follows that deficiency in the linguistic domain can contribute to general problem solving difficulties and vice versa (cf. Furth, 1976).

Teaching writing can be used as a content area to facilitate use of the content general procedures needed for efficient adult thought. Recall the language/cognition relationship discussed earlier.

2. Piaget's model of formal operational thought like other logical models is qualitative, not quantitative. Implications drawn from manipulation of propositions are stressed, not the knowledge of specific numerical or quantitative notions.

This priority for adult thought should be stressed to students, for all too many are prone to "dump" details and quantitative specifics on exams with no conclusions drawn. Writing is an excellent vehicle for discouraging this as we emphasize the use of specifics as supports for general theses in both paragraph and essay structure. This relativity of emphasis is engendered when we insist that students use details and examples to "prove a point" rather than as the point unto themselves. Some of our students, in fact, have to be guided from the point where they are expressing their thoughts in writing at a preoperational level by listing "heaps" or "complexes" of facts which bear some relationship to one another, with no explicit statement of organizing information. A further example of this behavior is the concentration on the narrative details of an instance when general conclusions are called for. Recently, in my basic writing class, when I asked students to write on the "increasing danger to individuals at rock concerts," four out of five students detailed one particular experience with no thesis statements or conclusions drawn. These students are now being exposed to formal paragraph structure: topic sentence, primary support statements, etc., to foster a concrete operational thought system where they have an awareness of superordinate and subordinate classes of statements as a way to express an argument. As a final goal, this system of classes

needs to be manipulated to reach conclusions, implications, etc., through the essay format to demonstrate formal operational thought. Again, language is used as a vehicle to teach. Another example is communicating the notion of subordination of ideas, not the definition of a subordinate clause. This priority cannot be stressed enough.

3. Piaget's model of formal operational thought emphasizes the need for separation of form and content. For example, a formal operational thinker can respond to the truth value of:

> All children like spinach.
> Boys are children.
> Therefore, boys like spinach.
> (example from Phillips, 1975)

They know this is true based on its form, while less mature thinkers respond to the truth or falsity of its content, regardless of form. Language has a vast array of uses with the college student in this regard, the enumeration of which is beyond the scope of this paper, for example, introducing the concepts of syntax as the "non-referential" aspect of language vs. semantics or meaning component. While these words need not be used, these notions raise awareness of form/content differences. Assigning students to argue for an idea to which they are opposed helps to foster this dichotomy.

4. Finally, it is important simply to note that Piaget's model is a competence, not a performance model. It is important to look at capability under the best circumstances, not mastery levels. Piaget's theory does not speak to motivational issues, although particular factors are necessary but not sufficient for attainment of formal operations (Ginsberg and Opper, 1969):

   a. maturation (neurological development)
   b. social environment

(1) education, instruction
(2) intellectual accomplishment of the culture from which student comes

c. experience with the physical world
d. equilibration, i.e., the individual's own activity for internal reorganization

It is with one or a combination of these factors with which we are faced with the "new college student" alluded to earlier. While our culturally different students may not have sufficiency in terms of factor (b) for academic success, research is beginning to suggest (d) as the crucial issue for the learning disabled. Although differing terminology is used across studies of the latter group, this general factor is indicated: for example, self-regulatory mechanisms (Reid, 1978); cognitive strategies (Michenbaum, 1977); and "executive schemes," "plans," and "control structures" in the information processing literature. A sense of control has to be restored in these and other ill-prepared college students in order to increase their perception of their capability to perform successfully. I am, therefore, suggesting that we use language teaching as a vehicle to foster this control by demonstrating language as a "system" over which the student has command and can use as a tool. Language has, in fact, been shown to have a facilitating effect on symbolic logic tasks (Furth, 1976). Students can be taught to view language as the embodiment of a logical system and be encouraged to generalize from it.

The Learning Cycle and Reading

Elaine Cohen

College students often read their textbooks without a conscious, systematic approach. Their eyes pass over every word in a chapter, but their minds may be elsewhere. Students may remember isolated details, but do not see relationships, making inferences, or synthesize information.

Learning cycles for the Reading Improvement course at Metropolitan State College were designed by Elaine Cohen and Mary Poppino to pose study problems which challenge students 1. to reflect on their own mental processes, 2. to share ideas with other students, and 3. to "invent" study techniques which will help them organize and use information effectively. Students apply the study strategies to their college texts. The learning cycles include study systems, comparing and contrasting, drawing inferences, and improving comprehension of main ideas.

JAN 19 1981

REFERENCES

Bates, E., The Emergence of Symbols, San Francisco: Academic Press, 1979.

Bates, E., Benigni, L., Bretherton, I., Comaioni, L., and Volterra, V., From gesture to the first word: On cognitive and social prerequisites. In M. Lewis and L. Rosenblum (Eds.), Interaction, Conversation, and the Development of Language, New York: Wiley and Sons, 1977.

Benne, Kenneth. The Learning Community. Presentation at the National Adult Education Conference, Boston, Ma., November 7, 1979. (Tape available from Monosette Productions, P. O. Box 02126, Portland, Oregon 97202)

Bowerman, M., Semantic and syntactic development. In R. Schiefelbusch (Ed.), Bases of Language Intervention, Baltimore: University Park Press, 1978.

Bronowski, Jacob. Science and Human Values. New York: Harper and Row, 1965.

Chickering, Arthur. "Adult Development: Implications for Higher Education," in The Adult Life Cycle: Training Manual and Reader. Vivian Rogers McCoy, Colleen Ryan, and James Lichtenberg, Lawrence, Kansas: University of Kansas, 1978, pp. 191-207.

Chomsky, N. Aspects of the Theory of Syntax. M.I.T. Press: Cambridge, 1965. (esp. Chp. 1 & 2)

Language and Mind. Harcourt, Brace & World: Chicago, 1968. (esp. p. 80)

Coleman, James S., "Properties of Experiential Learning" in Reflections on Experiential Learning and Its Uses, CAEL Working Paper #3, Educational Testing Service, Princeton, N. J., December 1974.

Conville, R. Cognitive Goals in Communication Learning. Communication Education, Vol. 26, March, 1977, 113-120

Cook, A., III. The Linguist and Language. Language: Introductory Readings. Second Edition. (Editors Clark, Eshholz, Rosa). St. Martins Press: New York, 1977.

Dewey, John. Experience and Education. New York: Collier, 1938.

Duckworth, Eleanor. "Either We're Too Early and They Can't Learn It or We're Too Late and They Already Know It: The Dilemma of Applying Piaget," Harvard Educational Review, Vol. 49, No. 3, August 1979, pp. 297-312.

Erikson, Erik H. "Dr. Borg's Life Cycle," in Adulthood, E. Erickson, ed. New York: W. W. Norton and Co., Inc., 1978, pp. 1-33.

Flavell, J., Cognitive Development, Englewood Cliffs: Prentice Hall, 1977.

Fuller, Robert G., "Recent Research Findings", Module 5 in College Teaching and the Development of Reasoning, Metropolitan State College Workshop, Denver, Colorado, November 1976.

Furth, H., and Youniss, J., Formal operations and language: A comparison of deaf and hearing adolescents. In D. Morehead and A. Morehead, Normal and Deficient Child Language, Baltimore: University Park Press, 1976

Galbraith, R. E. and T. M. Jones, Moral Reasoning: A Teaching Handbook for Adapting Kohlberg to the Classroom. Anoka, Minnesota: Greenhaven Press, Inc. 1976.

Gibson, Eleanor J., Levin, Harry, The Psychology of Reading, Cambridge, MA: MIT Press, 1975.

Gilligan, Carol, "In a Different Voice: Women's Conceptions of Self and Morality," in Stage Theories of Cognitive and Moral Development: Criticisms and Applications, Reprint #13, Harvard Educational Review, Cambridge, Mass., 1978, pp. 52-88.

Ginsburg, H. & Opper, S. Piaget: Implications for Education. Real Learning/A source Book for Teachers (Editors Silberman, Allender, Yanoff). Little, Brown & Co: Boston, 1976.

Piaget's Theory of Intellectual Development, Englewood Cliffs: Prentice Hall, 1969.

Goodnow, J. and Bethon, G., "Piaget's Tasks: The Effects of Schooling & Intelligence," Child Development, 1966, Vol. 37, pp.573-582.

Hallani, R.N., "Piaget and Thinking in History" in Martin Ballard (ed.), New Movements in the Study and Teaching of History, Bloomington, Indiana: Indiana U. Press, 1970, pp. 162-178.

Heron, A. "Concrete Operations, "g" and Achievement in Zambian Children," Journal of Cross-Cultural Psychology, 1971, Vol. 2, pp. 325-336.

Hooper, F. & Sheehan, N. Logical Concept Attainment During the Aging Years. Knowledge and Development. Volume 1. Advances in Research and Theory. (Editors Overton & Gallagher) Plenum Press: New York, 1977.

Inhelder, Barbel and Jean Piaget. The Growth of Logical Thinking from Childhood to Adolescence. New York: Basic Books, 1958.

Karplus, Robert, et.al., Science Teaching and the Development of Reasoning, Berkeley: University of California, 1978.

Kohlberg, Lawrence. "The Child as a Moral Philosopher," in Moral Education. B. Chazan and J. Soltis, eds. New York: Teachers College Press, 1973, pp. 131-144.

Kolberg, Lawrence and Rochelle Mayer. "Development as the Aim of Education," in Stage Theories of Cognitive and Moral Development: Criticisms and Application, Reprint No. 13, Harvard Educational Review, 1978, pp. 123-170.

Kolb, David and R. Fry. "Toward an Applied Theory of Experiential Learning," in Theories of Group Processes, C. Cooper, Ed., New York: John Wiley and Sons, 1975.

Kuhn, Deanna, "The Application of Piaget's Theory of Cognitive Development to Education," Harvard Educational Review, IL (No. 3): August, 1979, pp. 340-360.

Leonard, L., Cognitive factors in early linguistic development. In R. Schiefelbusch (Ed.), Bases of Language Intervention, Baltimore: University Park Press, 1976.

Levinson, Daniel with C. Darrow, E. Klein, M. Levinson, and B. McKee. Seasons of a Man's Life. New York: Alfred A. Knopf, 1978.

Long, Huey, Kay McCrary and Spencer Ackerman. "Adult Cognition: Piagetian Based Research Findings," Adult Education, Vol. 30, No. 1, 1979, pp. 3-18.

Lovell, K. & Shayer, M. Piaget and Science Curriculum Development. Knowledge and Development. Volume 2. Piaget and Education. (Editors Gallagher & Easley, Jr.) Plenum Press: New York, 1978.

Luria, A. Cognitive Development: Its Cultural and Social Foundations. (Editor M. Cole). Harvard University Press: Cambridge, 1976.

McCoy, Vivian Rogers. "Adult Life Cycle Change," Lifelong Learning: The Adult Years. October 1977, pp. 14-18, 31.

Michenbaum, David, Cognitive Behavior Modification: An Integrative Approach, New York: Plenum Press, 1979.

Mosher, Ralph and N. Sprinthall. "Psychological Education in Secondary Schools: A Program to Promote Individual and Human Development." American Psychologist, Vol. 25, No. 10, 1970, pp. 911-924.

Nystrand, Martin. Language as a Way of Knowing. Toronto: Ontario Institute for Studies in Education, 1977.

Odell, Lee, Piaget, Problem Solving, and Freshmen Composition, College Composition and Communication, 24(1973), 36-42.
The Process of Writing and the Process of Learning. College Composition and Communication, 31(1980), 42-50.

Phillips, J., The Origins of Intellect: Piaget's Theory, San Francisco: Freeman and Company, 1975.

Pianko, Sharon. A Description of the Composing Processes of College Freshmen Writers, Research in the Teaching of English, 13(1979, 5-21.

Piaget, J. The Psychology of Intelligence. Routledge & Kegan Paul LTD: London, 1967. (Esp. Chp. 11).
Six Psychological Studies. (Editor D. Elkind). Vintage Books: New York, 1968. (Esp. Chp. 3).
Structuralism. (Editor C. Maschler). Basic Books, Inc.: New York, 1970.
The Language and Thought of the Child. New York: New American Library, 1974.
The Psychology of Intelligence. Totowa, New Jersey: Littlefield, Adams and Co., 1976

Reid, D. K., Genevan theory and the education of exceptional children. In J. McCarthy Gallagher and J. Easley, Jr. (Eds), Knowledge and Development, Vol. II, Piaget and Education, New York: Plenum Press, 1978.

Rohwer, W., Jr., Ammon, P. and Cramer, P. Understanding Intellectual Development: Three Approaches to Theory & Practice. Dryden Press: Hinsdale, Ill, 1974.

Shuy, R. Dialects: How they Differ. Language: Introductory Readings. Second Edition. (Editors Clark, Esholz, Rosa) St. Martins Press: New York, 1977.

Tough, Allen. The Adult's Learning Projects. Toronto: Ontario Institute for Studies in Education, 1971

Vaillant, George. Adaptation to Life. Boston: Little, Brown, 1977.

Vygotsky, L., Thought and Language, Cambridge: MIT Press, 1962.

CONFERENCE PRESENTERS

Benson, Stephen E.
Department of Philosophy
Metropolitan State College
1006 11th Street
Denver, Colorado 80204

Bookman, Myra
Communication Disorders Clinic
University of Colorado-Denver
Box 88
1006 11th Street
Denver, Colorado 80204

Campbell, Thomas
Vice-President of Planning and
Informational Services
Illinois Central College
East Peoria, Illinois 61635

Carpenter, Elizabeth T.
University of Nebraska-Lincoln
Centennial Educational Program
540 North Sixteenth Street
Lincoln, Nebraska 68588

Cohen, Elaine L.
Department of Reading
Metropolitan State College
Box 17
1006 11th Street
Denver, Colorado 80204

Collea, Francis P., Chair
Department of Science Education
California State University, Fullerton
Fullerton, California 92634

Dyer, Eva O.
Academic Improvement Center
Learning Disabilities Program
Metropolitan State College
1006 11th Street, Box 40
Denver, Colorado 80204

Farkas, Paul D.
Department of English
Metropolitan State College
1006 11th Street, Box 32
Denver, Colorado 80204

Friot, Faith Elizabeth
Department of Education
Metropolitan State College
1006 11th Street, Box 21
Denver, Colorado 80204

Fuller, Robert G.
Department of Physics
University of Nebraska-Lincoln
Lincoln, Nebraska 68588

Gingras, Armando R.
Department of Mathematics
Metropolitan State College
1006 11th Street
Denver, Colorado 80204

Hahs, Sharon K.
Department of Chemistry
Metropolitan State College
1006 11th Street, Box 52
Denver, Colorado 80204

Hofmann, Susan
Counselor Psychologist
Metropolitan State College, Box 5
1006 11th Street
Denver, Colorado 80204

Hunter, Jacqueline
Department of Biology
Xavier University of Louisiana
New Orleans, Louisiana 70125

Jones, Lester
Department of Chemistry
Xavier University of Louisiana
New Orleans, Louisiana 70125

Killian, Patricia D.
Communication Disorders & Speech Science
University of Colorado-Denver
Campus Box 88, MA 108
1006 11th Street
Denver, Colorado 80204

Lancaster, Maureen P.
Study Skills Instructor
Special Services Program
Metropolitan State College
1006 11th Street
Denver, Colorado 80204

McShane, J. A.
Department of English
University of Nebraska-Lincoln
Lincoln, Nebraska 68588

Nummedal, Susan
Department of Psychology
California State University, Long Beach
Long Beach, California

P'Halloran, Gerald J.
Department of Physics
Metropolitan State College
1006 11th Street
Denver, Colorado 80204

Otto, Richard G.
Department of Philosophy
Metropolitan State College
1006 11th Street
Denver, Colorado 80204

Taylor, Karl
Chairman, Adult Basic Education Dept.
Illinois Central College
East Peoria, Illinois 61635

Thompson, Richard, Chairman
Social Science Department
Illinois Central College
East Peoria, Illinois

Vincent, Harold
Department of Physics
Xavier University of Louisiana
New Orleans, Louisiana 70125

Williams, Avalon M.
Department of English
Metropolitan State College
1006 11th Street
Denver, Colorado 80204

Wilson, Jerry H.
Department of Physics
Metropolitan State College
1006 11th Street, Box 69
Denver, Colorado 80204